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The European Emissions Trading System: Theoretical Analysis and Practical Observations

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Affidavit

I hereby declare that this master thesis has been written only by the undersigned and without any assistance from third parties.

Furthermore, I confirm that no sources have been used in the preparation of this thesis other than those indicated in the thesis itself.

Vienna, September 1st 2010

Georg Schmircher

Preface

I want to thank my family and all precious persons around me for their great motivation and encouraging words. Furthermore, I want to thank my sister, Mag. Teresa Schmircher, for proofreading my thesis very carefully. Finally, special thanks to my supervisor Dr. Wolfgang Weigel, University of Vienna, for his assistance and inspiring support during the whole time. It has been a pleasure working this way.

Georg Schmircher

Abstract (English)

The following thesis deals with the theoretical functionality and the practical design of the European Emissions Trading System. The theoretical concept of environmental trading systems was invented by John H. Dales in 1968. It is usually judged very positively in economic literature, but it also requires some preconditions like low transaction costs that complicate the implementation process. During its first period, the European Emission Trading System, established in 2005, faced a variety of serious troubles. The decentralised approach to let member states decide about the number of allocated certificates as well as about the allocation formulas resulted in an extensive over-allocation of emission permits and a sharp price drop down to a few cents per CO_2 certificate. Windfall profits endangered the credibility of the system. The threat of carbon leakage, on the other hand, resulted in a cautious handling of severe regulations. The EU ETS is the first trading system of its size and internationality. Therefore, initial troubles are not surprising. The trading system and the price development have stabilised during the second trading period. Planned alterations for the third trading period, which starts in 2013, give further reasons for optimism that the EU ETS can finally develop its advantage of cost-efficiency and become a powerful tool of the European climate policy.

Abstract (Deutsch)

Die folgende Diplomarbeit behandelt das theoretische Design und die praktische Ausgestaltung des EU Emissionshandels. Das theoretische Konzept handelbarer Umweltlizenzen wurde schon 1968 von John H. Dales entwickelt. In der ökonomischen Literatur wird es überwiegend positiv bewertet. Allerdings wird der Implementierungsprozess durch wichtige Voraussetzungen, beispielsweise niedrige Transaktionskosten, kompliziert. Während der ersten Handelsperiode kam es zu einer Reihe ernster Probleme. Der dezentralisierte Ansatz, die Mitgliedsstaaten selbst über die Anzahl der bereitgestellten Zertifikate und die Allokationsformeln entscheiden zu lassen führte zu einer erheblichen Überallokation und zu einem scharfen Kursverfall. Hohe Gewinne energieintensiver Unternehmen gefährdeten die Glaubwürdigkeit des Systems, andererseits hatte die Gefahr von Wettbewerbsnachteilen einen vorsichtigen Umgang mit strengen Regulierungen zur Folge. Das EU Emissionshandelssystem ist das erste Handelssystem mit Umweltzertifikaten dieser Größe und Internationalität, einige Anlaufschwierigkeiten sind deshalb nicht überraschend. Während der zweiten Handelsperiode konnte das Handelssystem stabilisiert werden, die Preisentwicklung verläuft seitdem relativ konstant. Die geplanten Änderungen für die dritte Handelsperiode ab 2013 geben Grund für weiteren Optimismus. Das EU Emissionshandelssystem könnte nun endlich seine potenzielle Stärke der Kosteneffizienz ausspielen und zu einem mächtigen Werkzeug der europäischen Klimapolitik werden.

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List of abbreviations:

AAU	Assigned Amount Unit
AD	anno Domini
AIJ	Activities Implemented Jointly
C	Celsius
CDM	Clean Development Mechanism
CER	Certified Emission Reduction
CFC	Chlorofluorocarbon
CH_4	Methane
CO_2	Carbon dioxide
COP	Conference of the parties
d	demand curve
D	Germany
del	demand of emission licenses
e	emission quantity
ec	emission costs
ecc	emission consequential costs
EC	European Commission
ECCP	European Climate Change Programme
ECX	European Climate Exchange
EEX	European Energy Exchange
EKC	Environmental Kuznets Curve
el	quantity of emission licenses
emc	external marginal costs
erc	emission reduction costs
ERU	Emission Reduction Unit
EU	European Union
EU ETS	European Emissions Trading System
EUA	European Union Allowances
EUR	Euro
GDP	Gross domestic product
GNP	Gross national product
GHG	Greenhouse gas
H_2O	Water vapour
HFC	Hydrofluorocarbon
ICAP	International Carbon Action Partnership
IPPC	Intergovernmental Panel of Climate Change
JI	Joint Implementation
mac	marginal abatement costs
md	marginal damage

mecc	marginal emission consequential costs
merc	marginal emission reduction costs
MW	Megawatt
N_2O	Nitrous oxide
NAP	National Allocation Plan
O_3	Ozone
p	price
p.	page
pmb	private marginal benefits
pmc	private marginal costs
q	quantity
PFC	Perfluorocarbon
s	supply curve
sel	supply of emission licenses
SF_6	Sulphur Hexafluoride
smb	society-wide marginal benefits
smc	society-wide marginal costs
t	tax rate
t	tonne
UK	United Kingdom
UNCED	United Nations Conference on Environment and Development
UNEP	United Nations Environmental Program
UNFCCC	United Nations Framework Convention on Climate Change
US	United States
USA	United States of America
WMO	World Meteorological Organization

1. Introduction

In 1968, John H. Dales developed a theoretical concept of a tradable certificates system to efficiently internalise external effects and account for environmental goods in economic theory. Even though his ideas were received positively in economic literature, his concept was hardly used in practical politics for a long time. Finally in 2005, due to the emission reduction and limitation commitments of industrialised nations under to the Kyoto Protocol, the European Union established an emissions trading system for greenhouse gases that is meant to be a role model for worldwide emissions trading in the future. In my diploma thesis, I connect the economic theory of the tradable permits solution to the practical design and functionality of the European Emissions Trading System, discuss advantages and disadvantages of the licence solution and point out possible improvements so that the trading system can be more successful in the future.

As an introduction to the topic, chapter 2 briefly discusses the greenhouse effect and the phenomenon of global warming. Although the global climate is much too complex to have absolute clarity about causes and consequences, leading scientists believe that human activity is the major cause for the increase in the mean global temperature during the past decades. Furthermore, this chapter sketches the international negotiations on climate protection that resulted in the ratification of the Kyoto Protocol in 2004.

Chapter 3 explains the problem of accounting for environmental goods in economic theory and summarises the history of attempts to internalise negative external effects. The chapter illustrates the Pigou taxation, the Coase-Theorem, the standard-price-approach and the Clarke solution. Finally, the chapter explains the basic principles of the tradable permits system developed by John H. Dales in 1968 that is the theoretical fundament of the emissions trading system in Europe.

Chapter 4 focuses on the theoretical analysis of the tradable permits solution. It illustrates how supply and demand interact in an emissions market and shows the enormous benefit of economic efficiency of this policy instrument. This chapter also discusses the ecological effectiveness and regulative compliance and demonstrates the importance of transaction costs.

Chapter 5 explains the practical design and functionality of the European Emissions Trading System. It illustrates the basic principles of emissions trading in the first two trading periods and the climate strategy package and gives an outlook on the third trading period starting in 2013.

Chapter 6 finally deals with current issues and challenges of the European Emissions Trading System and recommends possible improvements for future trading periods.

Since the European Emissions Trading System is the first trading scheme of this size, it is understandable that some start up time is needed to design the framework properly. Nevertheless, for the European Union in order to maintain its global front-running role in the area of climate protection, significant improvements of the trading system are crucial to establish this policy mechanism as a role model for future worldwide emissions trading.

2. The phenomenon of global warming

For centuries, environmental goods like water and air were considered to be common goods, meaning that the utilisation of these goods by one market participant would not affect other participants. Since industrialisation and increasing environmental pollution, this perception became less and less true. Today, it is the challenge of environmental economics to assign an economic value to environmental goods and to develop approaches for the efficient internalisation of environmental pollution.

Global warming, more precisely the rise of the mean global temperature, is one of the most important and controversial environmental problems of our time. Although the global climate is a very complex process, most scientists believe that human behaviour, especially the burning of fossil fuels, is the major reason for this climatic transformation. This realisation is the starting point for climate protection negotiations, for the reduction and limitation commitments according to the Kyoto

Protocol and, finally, for the establishment of the European Emissions Trading System. Therefore, we will start our analysis by briefly discussing the phenomenon of global warming and its possible consequences.

2.1. Scientific explanation of the greenhouse effect

The greenhouse effect, discovered by Joseph Fourier in 1824, means the increase of the global temperature because of greenhouse gases in the atmosphere. It can be divided into the natural and the anthropogenic greenhouse effect. According to the majority of scientists, the anthropogenic (human-caused) greenhouse effect is the most important reason for global climate change.

2.1.1. The natural greenhouse effect

The term "climate" is defined as the statistically adjusted condition of the earth's atmosphere over several decades (Schenk, 2005, p.3). The earth's atmosphere functions similarly to the glass roof of a greenhouse. Short-waved solar radiation passes unhindered through the earth's atmosphere. In the course of the reflection by the earth it becomes long-waved. A mixture of greenhouse gases absorbs radiation within the thermal infrared range. Therefore, only a part of the radiation arrives back in space, the other part warms up the earth and its atmosphere. This procedure is called the natural greenhouse effect (shown graphically in figure 2.1[1]).

Although the greenhouse gases make up only about 1% of the atmosphere, they play a vital role in the earth's climate system (Stowell, 2005, p.3). The procedure leads to a heating of the earth's surface until a condition of equilibrium is reached. At present the mean global temperature is 15°C. Without any atmosphere the mean global temperature would be approximately -18°C (-20°C), 33°C lower than actually. Therefore, without the greenhouse effect human existence would not be possible (Schenk, 2005, p.3).

[1] http://www.greenpeace.org/international/en/multimedia/photos/greenhouse_effect, downloaded on May 25, 2010

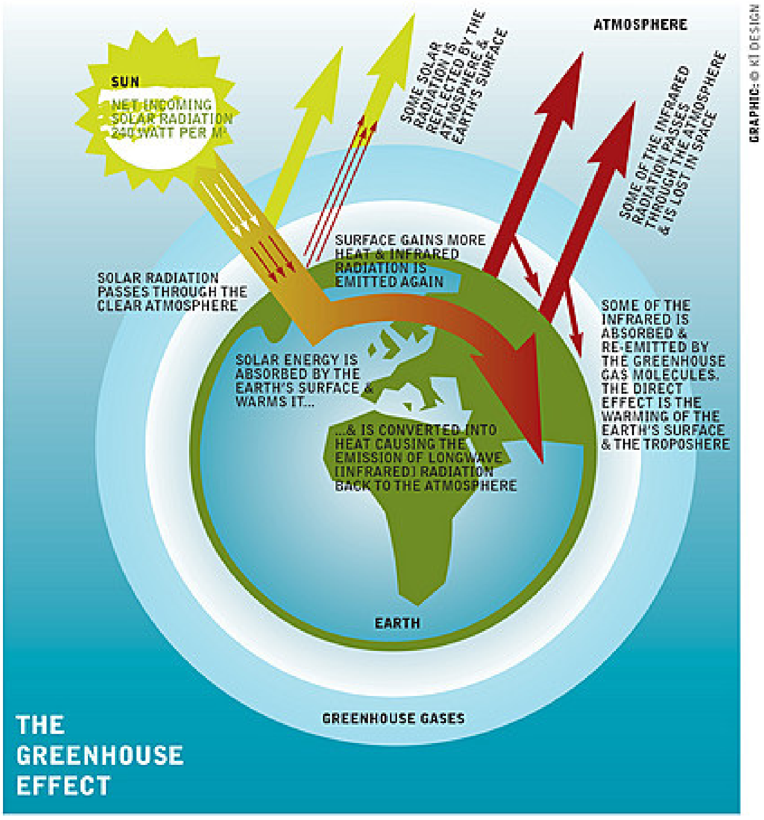

Figure 2.1: The natural greenhouse effect

Climatic effective atmospheric gases are, inter alia, CO_2 (carbon dioxide), H_2O (water vapour), O_3 (ozone), CH_4 (methane), and N_2O (nitrous oxide). These gases are contained in the atmosphere also without human activities and, therefore, responsible for the natural greenhouse effect. Any change in the composition of these gases in the atmosphere leads to a modification of the transmissibility of the earth's heat radiation. The impact of these gases on the greenhouse effect depends on their atmospheric concentration, on different molecular characteristics and on the retention time in the atmosphere (Lucht, 2005, p.1). The global warming potential shows the impact of the emission of a specific greenhouse gas on global warming, compared to the same quantity of CO_2. It is summarised for the six major greenhouse gases in figure 2.2, based on Stowell, 2005, p.5.

Greenhouse gas		Global Warming Potential
Carbon Dioxide	CO_2	1 CO_2 equivalent
Methane	CH_4	21 CO_2 equivalents
Nitrous Oxide	N_2O	310 CO_2 equivalents
Hydrofluorocarbons	HFCs	100-12,000 CO_2 equivalents
Perfluorocarbons	PFCs	6,500-9,200 CO_2 equivalents
Sulphur Hexafluoride	SF_6	23,900 CO_2 equivalents

Figure 2.2: Global warming potential of the six major greenhouse gases

2.1.2. The anthropogenic greenhouse effect

Since industrialisation human economic activity goes hand in hand with the continuously increasing consumption of resources. Therefore, to an increasing degree also climatic relevant gases are laid off into the atmosphere. In the course of this process also synthetic greenhouse gases like CFCs (chlorofluorocarbon) emerge. Burning of fossil energy sources, industrial processes, modified use of land, and extensive forest clearance lead to an amplification of the natural greenhouse effect. This part of the greenhouse effect that can be traced back to human activity is called the anthropogenic greenhouse effect. Scientists estimate that around two thirds of the greenhouse gases that emerge because of human activity are due to the production and utilisation of energy (Schenk, 2005, p.4-5). CO_2 evolves through the burning of fossil energy sources. It is only partly stored in the vegetation, in humus, and in the sea. Although it is the least effective greenhouse gas per unit emitted (see figure 2.2), due to large emission levels and a long lifespan in the atmosphere, carbon dioxide is the largest single contributor to the greenhouse effect (Springer, 2002, p.12).

2.1.3. Consequences of global warming and the problem of scientific proof

Although a majority of scientists regard a causal connection between the anthropogenic greenhouse effect and global warming as given, a serious registration of faults is very hard because of the complexity of the ecological system. Thus, controversial scientific discussions about the degree and possible impacts of the climatic change take place. The most important evidence of global warming is the increase of the mean global temperature by 0.6°C since the beginning of the systematic temperature measurement and record in the year 1861 (Lucht, 2005, p.3).

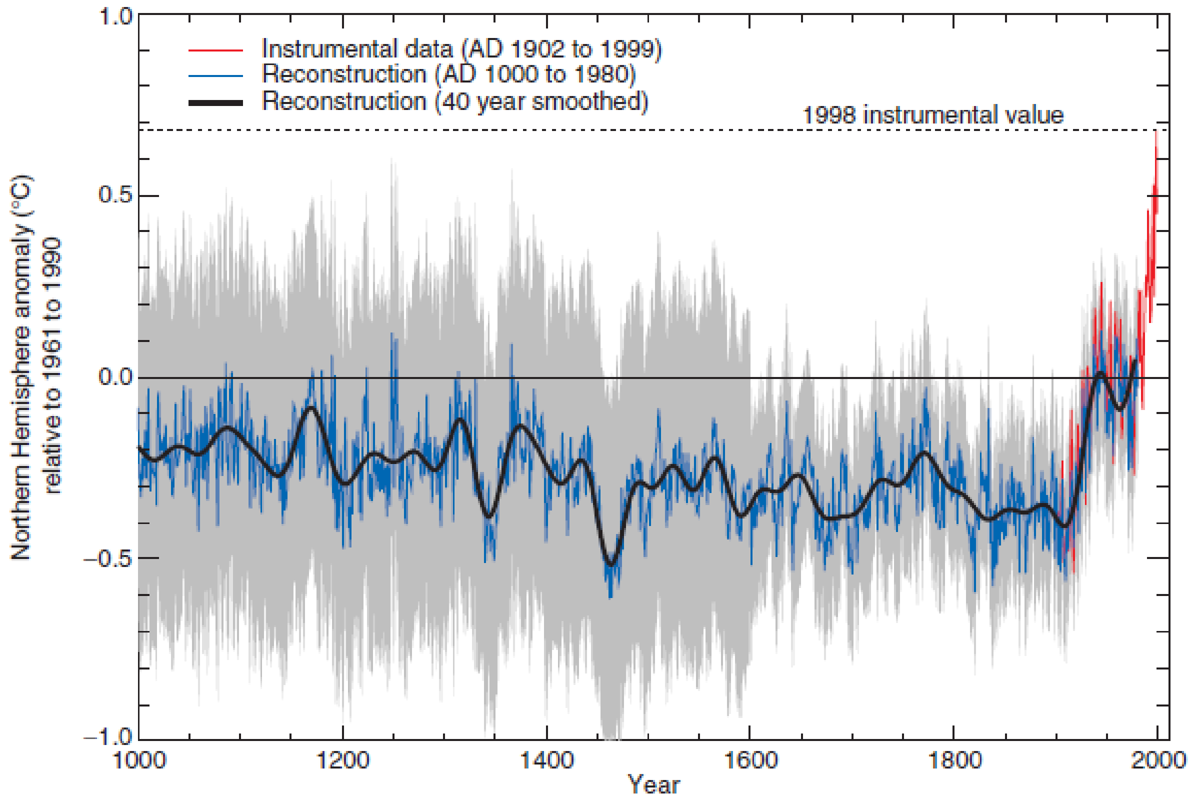

Figure 2.3: Temperature increase in the Northern Hemisphere

Figure 2.3, extracted from the third IPPC Assessment report, shows the temperature increase in the Northern Hemisphere over the last 1,000 years. Climatic causal interactions are very complex. Besides the concentration of greenhouse gases, other factors of influence are controversial in their mode of operation, for example fluctuations of the intensity of solar radiation or volcanic activities. These parameters further complicate a clear verification of anthropogenic causes of global warming. However, in the light of looming global menaces, global risk management strategies that go beyond the waiting for definite proof seem necessary.

The Intergovernmental Panel on Climate Change (IPPC) is a scientific body that periodically reviews the climate's situation and publishes its results in Assessment

Reports. It was founded in 1988 by the World Meteorological Organisation (WMO) and the United Nations Environmental Program (UNEP) to provide governments and decision-makers with a clear scientific view on the development of the world's climate. Up to now the IPPC has published 4 Assessment Reports; the Fifth Assessment Report is currently under progress and will be finalised in 2014[2]. In 2007 the organisation, together with the former US Vice President Al Gore, was honoured with the Nobel Peace Prize.

In the Fourth IPPC Assessment Report, published in 2007, scientific fundamentals of the climate change are explained, likely implications discussed and mitigation strategies recommended. In the last 100 years (1906 to 2005), warming has caused about a 0.74°C increase in global average temperature. Furthermore, eleven of the last twelve years (1995 - 2006) rank among the 12 warmest years in the instrumental record of global surface temperature since 1850. The report emphasises human responsibility for the climatic change. With a likelihood of over 90%, the major reason for the temperature increase are human emissions of carbon dioxide, followed by further greenhouse gases and various other factors. Figure 2.4, extracted from the fourth IPPC Assessment Report, shows the major radiative forcing components. It clearly depicts the influence of greenhouse gases on the current temperature rise.

The report lists a series of aftermaths of the temperature and climate change, inter alia, a global average sea level rise, melting glaciers, losses of ice sheets, and an augmentation of extreme weather occurrences, including droughts, heavy precipitation, heat waves, and tropical cyclones. In the future a further temperature increase is expected. Different scenarios have been developed to forecast the quantity of the warming. They rely on variable assumptions like demographic development and economic growth. In the best-case scenario, the temperature rise until the decade 2090 – 2100 is calculated to be 1.8°C (with a likely range of 1.1 to 2.9°C). The most disadvantageous case estimates an increase of 4.0°C (2.4 – 6.4°C). Consequently, the expected sea level rise lies somewhere between 18-38 and 26-59 centimetres. Because many natural processes react very lethargically, scientists estimate that even if all CO_2 emissions were stopped immediately, the

[2] The economist William D. Nordhaus, professor at Yale University, reviewed the IPCC's activities in his book „Economics and policy issues in climate change" and addresses specific economic questions regarding climate change policy.

earth's temperature as well as the sea level would continue to rise for centuries (Stix, 2007, p.13).

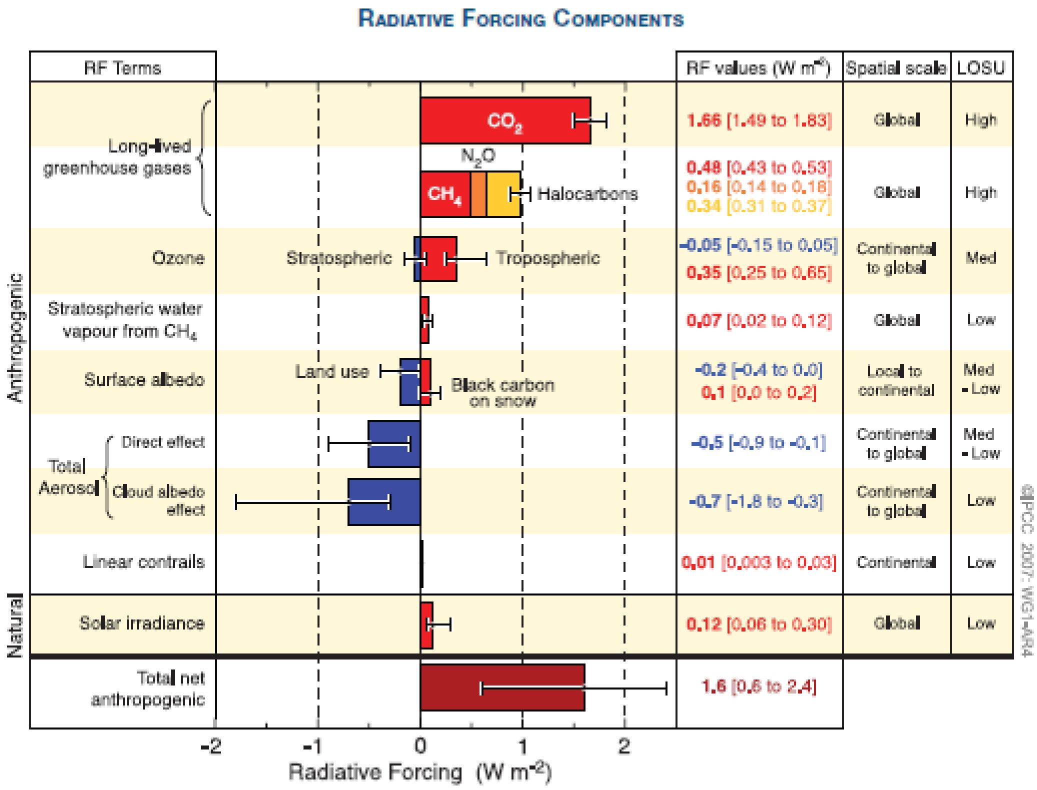

Figure 2.4: Radiative forcing components

Regarding future implications of climate change, water availability is projected to increase at high latitudes and in some wet tropical areas, but decrease in some dry regions at mid-latitudes and in the dry tropics. The adaptability of ecological systems could be overstrained by increased occurrences of floods and droughts. This is likely to have negative impacts on the biodiversity as well as on food production. Furthermore, millions of people will be affected by the sea level rise, especially in the mega-deltas of Asia and Africa. Since developing countries tend to have more limited adaptive capacities, they are especially vulnerable. Hence, ironically, the adverse impacts of the temperature change first hit those countries not responsible for the anthropogenic greenhouse effect in the first place (Weirig, 2005, p.8).

2.2. Political arrangements for climate protection

The rise of the mean global temperature, the realisation that human behaviour is probably the main reason for this climatic change, and the urgency of this problem create a need for quick global political arrangements. Even so, it was not until the Kyoto negotiations in 1997 that a majority of countries agreed on emission limitation and reduction obligations.

2.2.1. International negotiations on emission reductions

During the mid 1980s, climate change slowly became a topic in the international debate. In June 1992 the United Nations Conference on Environment and Development (UNCED, the Earth Summit) took place in Rio de Janeiro, Brazil. By then it was the greatest international conference and delegates of nearly all governments of the world as well as many non-governmental organisations participated in the negotiations. During this convention many multilateral environmental agreements were made, among them the United Nations Framework Convention on Climate Change (UNFCCC). The convention had the objective to obviate any dangerous anthropogenic interference with the earth's climate system. The Precautionary Principle, defined in the convention, says that specific actions for climatic protection must be taken even in the absence of final scientific proof. Greenhouse gas emissions shall be abated back to the level of 1990 in industrialised nations. To reach this commonly defined goal, the convention stipulates additional protocols or other judicial agreements that contain more specific climate protection commitments. The central idea is the principle of mutual but diverse responsibilities, meaning that the industrialized nations, responsible for the climate change in the first place, have to take the lead in climate protection. The treaty does not contain binding commitments but it had great impact in clearing the way for further negotiations.

The UNFCCC entered into force in 1994. One year later the First Conference of the Parties to the UNFCCC (COP-1) met in Berlin, Germany. In the course of this meeting, the participating nations agreed on the Berlin Mandate. An ad hoc group was instituted that should develop a protocol containing specific and binding targets for emission reduction in industrialised nations as well as a time limit for their realisation. The negotiating parties also agreed on the implementation of a pilot phase for Activities Implemented Jointly (AIJ), a flexible instrument of emissions trading. In the forefront of the second conference (COP-2) in Geneva, Switzerland, the task force had already held three preparatory meetings. After a complicated election process, the delegates agreed on the Geneva Ministerial Declaration. The conclusions of the Second IPPC Assessment Report, finished in 1995, showed for the first time showed a scientific connection between anthropogenic emitted greenhouse gases and the climate changing process. It became the scientific basis for further processes in the international climate protection policy. Furthermore, the upcoming elaboration of a legally binding regulation of the reduction of greenhouse gases was underlined. In the following month many concepts and components of a climate protection protocol were discussed at various meetings. The European Union took a frontrunner position in proposing ambitious reduction targets. The Umbrella Group[3], on the other hand, was especially interested in maximal flexibility but shied away from the presentation of specific reduction targets. Furthermore asymmetries between the industrialised nations and developing countries seriously complicated the negotiation process (Dzenan, 2008, p.40). Hence, it was not until the final conference of the negotiation cycle in Kyoto, Japan, that a commonly accepted result was achieved.

2.2.2. The Kyoto Protocol and beyond

In the course of the Third Conference of the Parties (COP-3) in December 1997 in Kyoto, the main features of the preliminary protocol, developed by the task force of the Berlin Mandate, were negotiated. In the end a consensus concerning specific reduction targets of all industrialised nations was reached. However, many other critical matters remained ambiguous and were postponed to later meetings.

[3] The Umbrella Group, also called JUSSCANNZ, is an alliance of industrialised non-members of the European Union, namely Japan, USA, Switzerland, Canada, Australia, Norway and New Zealand.

The Kyoto Protocol divides the world's nations into two groups, the Annex-B-Countries[4] and all other nations (Non-Annex-B-Countries). The Annex-B-Countries are obligated to jointly reduce their greenhouse gas emissions by 5% compared to the level of 1990 in the time period 2008 – 2012. Annex A of the protocol specifies six greenhouse gases[5] that are covered in this agreement. The individual countries have very diverse reduction targets that mostly depend on their economic development level. The European Union, for example, has agreed to jointly reduce greenhouse gas emissions by 8%, and the United States has to cut their emissions by 7%[6]. Australia is allowed to increase its emissions by 8%, while Russia agreed to keep its emissions constant.

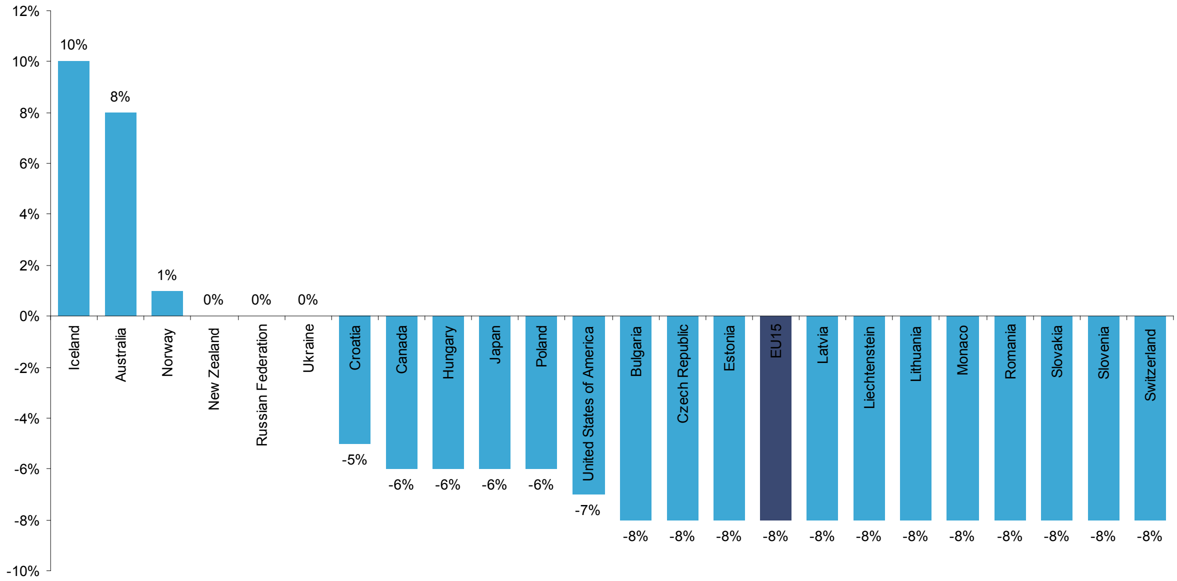

Figure 2.5: Emission limitation and reduction commitments as percentages of the base years or periods[7]

According to article 4 of the protocol, the European Union decided to redistribute their emission reduction targets under the condition that the common reduction quantity remained the same. Hence, the Burden Sharing Agreement was developed in 1998. Precondition for the protocol to enter into force was the signature of at least 55

[4] EU15, USA, Canada, Australia, New Zealand, Japan, Switzerland, Norway, Liechtenstein, Monaco and the European countries in transformation.

[5] Carbon dioxide (CO_2), Methane (CH_4), Nitrous oxide (N_2O), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs) and Sulphur hexafluoride (SF_6).

[6] The USA initially signed the Protocol but did not ratify it. Therefore, the USA is not committed to any binding greenhouse gas reductions.

[7] The commitments are defined in Annex B of the Kyoto Protocol.

nations responsible for at least 55% of all greenhouse gases worldwide in the year 1990.

The negotiation results immediately met with severe and diverse criticism. While environmental activists were disappointed by the humble reduction targets that could not possibly solve the threat of climatic change, economists feared high implementation costs of the protocol.

After the Kyoto conference, a process of continued negotiations started to improve the protocol and to close its last gaps, but the meetings were characterised by various challenges and controversial issues (Dzenan, 2008, p.76-80). In March 2001 US President Bush announced that the United States would not ratify the protocol. While some speculated that this decision would mean the end of the protocol, it had the unintended effect to galvanise the remaining participants (Stowell, 2005, p.26). At the COP-7 in Marrakech, Morocco, in 2001, an agreement was passed (The Marrakech Accord) that specifies the exact assessment base for emissions and their reductions. After the US rejection, the Russian signature was crucial for the protocol to become effective, and in November 2004 Russia finally ratified the protocol. The Kyoto Protocol, therefore, entered into force on February 16, 2004 (Schenk, 2005, p.10).

Since the scope of the Kyoto Protocol ends in 2012, a successive regime is absolutely essential by now. Great expectations were laid on the COP-15 in Copenhagen, Denmark, that, according to the Bali roadmap (developed during the United Nations Climate Change Conference in Bali in December 2007), should create a successive binding regime, but negotiations failed spectacularly. The Copenhagen Accord only mentions the target to narrow global warming to less than 2°C compared to pre-industrial times, but no specific reduction targets were resolved. While most governmental representatives tried to find positive words, the international press as well as environmental organisations reacted disappointedly. In their first reaction, the German newspaper “Die Zeit” titled “Euthanasia for the world climate” and “The miserable end of a great hope”, the newspaper “Die Welt” (D), on the other hand, tried to be as optimistic as possible: “Copenhagen is no cause for pessimism”. The Times (UK) spoke of a “lukewarm climate change deal in Copenhagen”. The New

York Times (USA) wrote about “A Grudging Accord in Climate Talks” although US newspaper headlines were dominated by the current healthcare reform plans of President Barack Obama. Hopes now concentrate on COP-16 in Mexico City in 2010 to agree on a successive document for the expiring Kyoto Protocol.

2.2.3. Flexible instruments of the Kyoto Protocol

The Kyoto Protocol lays great emphasis on flexibility in order to hold down the costs and disruptions of emission control. Therefore, the protocol contains the basis for an international trading system by establishing three market-based mechanisms, namely International Emissions Trading, Joint Implementation (JI) and the Clean Development Mechanism (CDM). The basic principle is that emission saving activities can be done where they are most cost efficient.

International Emissions Trading, specified in Article 17 of the Kyoto Protocol, means the trading of emission permits between Annex B countries. Trading is done by using Assigned Amount Units (AAUs), standardised quantity units measured in tonnes of CO_2 equivalents. The Kyoto Protocol, therefore, allows countries to meet their reduction commitments by purchasing reductions beyond their own target. International Emissions Trading is possible only between Annex B countries without constraint as from 2008.

Article 6 of the Kyoto Protocol, commonly referred to as Joint Implementation, is a project-based mechanism that requires ex-post verification of emission reductions in order to generate credits. Countries with targets defined in Annex B of the Protocol, or companies in these countries, are able to enforce emission reduction projects in other Annex B countries. Credits can be earned by using Emission Reduction Units (ERUs). Transfer and Acquisition under International Emissions Trading and Joint Implementation are a zero-sum game within the overall Annex B target of minus 5% compared to 1990 levels in industrialised nations. JI projects are allowed as from 2008.

The Clean Development Mechanism functions similarly to Joint Implementation, only projects have to take place in non-Annex-I-Countries. Therefore, the reduction credits generated under this programme are not part of the overall cap on emissions under the protocol. Crediting is done by using Certified Emission Reductions (CERs). They can be used backdated to the year 2000. Possible examples are the funding of regenerative energy sources, efficiency improvements in the generation of electricity, and energy consumption. It is the ambition of the Clean Development Mechanism not only to lower emissions but also to support poorer countries on their way to sustainable development.

3. Environmental goods in the economic theory

Environmental economics deals with the causes and solution possibilities of environmental problems. The upcoming chapter discusses the problem of assigning an economic value to environmental goods and shows the history of internalizing external effects, which leads to the invention of tradable environmental licenses.

3.1. The economic value of environmental goods

Welfare economics studies how the allocation of resources affects the economic welfare of a society (Mankiw, 2004, p.151). On the one hand, welfare economics tries to determine efficient allocation of resources (the allocation theory); on the other hand, its purpose is to find criteria to choose between different efficient allocations (Rudolph, 2005, p.32). Since Adam Smith published his famous “Wealth of nations” the dominant idea has been that common wealth is best achieved through decentralised coordination of individual economic plans through the invisible hand of the market (Rudolph, 2005, p.32). Self-interests contribute to the augmentation of common wealth. Unfortunately, in some situations individual rational actions do not lead to this desirable society-wide outcome. The most important reason for the divergence between individual and collective rationality is the appearance of external effects. Hence, the price of a good as a scarcity signal does not fulfil its coordination function and the allocation result becomes suboptimal.

In economic theory, economic goods contribute to the satisfaction of individuals' needs directly or indirectly. Therefore, environmental goods are also economic goods. In traditional environmental economics, the natural environment has a function as consumption good, provider of resources, and pollution recipient. Further examination shows the ecological importance for climate regulation, diversity of species, the self-regulation ability of ecological systems, and many more (Marggraf, Streb, 1997, p.27). Environmental goods have an enormous relevance in the economic process. Only if scarcity of a good exists, the good is linked to an economic value, meaning that opportunity costs occur because of different possible applications. These opportunity costs are lost utilisation possibilities regarding the second-best alternative of a specific good. The scarcity of a good depends on the relationship between applications demanded and the supplied quantity. Thus, economic scarcity and economic value are relative terms. The supply of environmental goods is dependent on natural processes. On the other hand, especially in the course of industrialization, the demand for environmental goods has been characterised by extraordinary growth. This relative scarcity leads to an increase in the economic value of environmental goods.

The cause of environmental problems is an imperfect realisation of human preferences. Any solution to these problems must base on institutional changes that alter human behaviour to make it more compatible with environmental protection (Mercuro, López, Preston, 1994, p.103).

Environmental goods can be viewed as scarce economic goods just as any other market goods. The rational handling of scarce goods is to utilise them in the best possible (meaning efficient) manner. In economic theory, efficiency means that no further enhancement is possible, considering the scarcity of resources and the ultimate goal of maximising the satisfaction of individuals' needs. Because efficiency is the best reachable situation, economically efficient situations are said to be optimal situations. For the efficient use of economic goods, the aggregated weighting of costs and benefits is necessary. The aggregated benefit of a good is its utilisation according to the chosen direction. The aggregated costs, on the other hand, equal the opportunity costs of a good. In economic theory, a good is used efficiently if the distance between the aggregated benefits and costs are maximised.

Nowadays, ecological resources are overstrained compared to an efficient utilisation. As measured by the increased demand of environmental goods, the supply is simply too low. The reason behind this problem is that environmental goods are characterised by attributes that obviate the trading of these goods on markets and, thus, distort the reflection of the scarcity on market prices. The coordination of economic activities with the help of market prices only leads to economically efficient situations if these prices are reflected correctly by the costs occurring during the utilisation of these goods. If this is not the case, external effects occur (Nowotny, 1987, p.33-34).

Figure 3.1 (Marggraf, Streb, 1997, p.33) shows the impact of negative external effects on the economic outcome. In situations without external effects, private marginal costs (pmc) and society-wide marginal costs (smc) coincide. If external effects appear, this is not the case. The fact that only private marginal costs are considered in economic decisions leads to an exorbitant supply of the economic good compared to the efficient quantity q_{eff}.

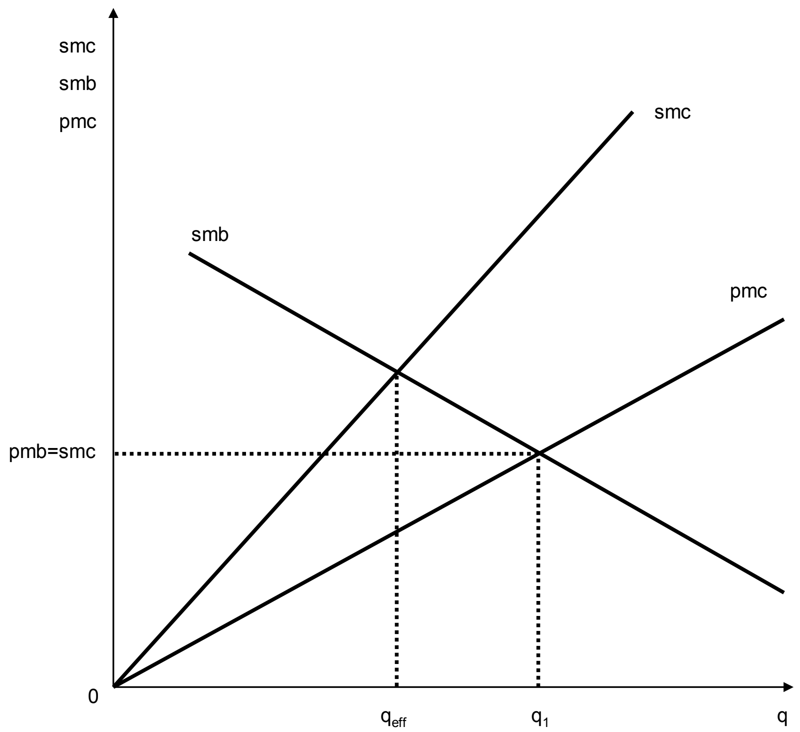

Figure 3.1: The impact of negative external effects

As we see, environmental pollution can be interpreted as the inefficient utilisation of scarce environmental goods. The reason that the pricing mechanism fails in these cases is due to two characteristics. Firstly, many individuals can jointly use environmental goods without rivalry. Secondly, it is often not possible to exclude individuals from utilisation. Typically, environmental goods are collective goods since they are jointly used by a great number of individuals. In general, the benefit of a single individual is smaller than the provision costs of an environmental good. Nevertheless, the supply of the ecological good is efficient if the cumulated benefits of all consumers exceed the costs of provision. The individual's contribution is too small to generate a noteworthy improvement, which is why it is never rational for a single individual to contribute to the incoming costs. This dilemma leads to a situation in which every consumer hopes that other consumers provide for the supply so that utilisation becomes free of charge. This phenomenon is called the prisoners' dilemma.

Because environmental goods are not provided efficiently by the market, the need for governmental interference emerges. Political decision-makers, instead of the market, need to allocate ecological goods among competing applications. To do so, different eco-political instruments are available, ranging from environmental obligations over the ascertainment of taxes to the distribution of certificates. Assuming that political decision-makers act in the best interest of the communality, their target is to maximise the macroeconomic optimal situation. Hence, it is necessary to allocate environmental goods in an efficient way. For this purpose the state needs to know the aggregated costs and benefits according to the different possible applications. In other words, politicians are required to know the economic values of environmental goods.

3.2. The history of internalising external effects

Environmental goods are usually treated as common goods but, on the other hand, they are becoming more and more scarce because of environmental pollution (see chapter 3.1). This contradiction raises the question of how to deal with them in economic theory. The history of internalising external effects and accounting for environmental pollution in economic theory started with the invention of the Pigou tax in 1920. In 1968, John H. Dales developed a system of tradable permits. This conception is now the theoretical foundation of the European Emissions Trading System.

3.2.1. The Pigou taxation

In 1920, Arthur Cecil Pigou[8], a British economist, argued that all costs of economic activities have to be covered in the price system. Only if all costs are comprised in the allocation decision of economic agents do they reflect the scarcity of resources and, therefore, lead to an efficient allocation of goods. The Pigou tax attempts to internalise negative external effects through governmental interference, and to integrate them into the price system. In the social optimum, the rate of taxation on the originator must be equal to the external marginal costs (Rudolph, 2005, p.24). In other words, the causer of external effects has to be taxed so that the social and private marginal costs are equal at the macroeconomic optimal production quantity. Otherwise, the individual pursuit of self-interests (the invisible hand of the market) will not lead to the maximal welfare value of the society.

In figure 3.2 (based on Fritsch, Wein, Ewers, 2003, p.122) the supply curve s represents the private marginal costs (pmc). Furthermore, additional external marginal costs (emc) occur. If the supplier considers all costs from the production process (pmc+emc), the intersection of the social marginal costs (smc) curve and the demand curve d shows the market equilibrium (Point A) that is the macroeconomic optimum. Without internalisation, negative external effects lead to the equilibrium B, a situation in which the realised quantity q_1 is too large and the price p_1 is too low. The analogy of private and social marginal costs aspired by Pigou can be realised by a proportional tax per quantity unit, discharged by the suppliers. The tax rate t must meet the social additional costs at the optimal quantity q_2 (t=AC). In this case, the supply curve moves to s+t and the intersection with the demand curve corresponds to the macroeconomic optimum (q_2,p_2).

[8] In 1908 Pigou succeeded his teacher, the famous English economist Alfred Marshall, as professor of political economy in Cambridge.

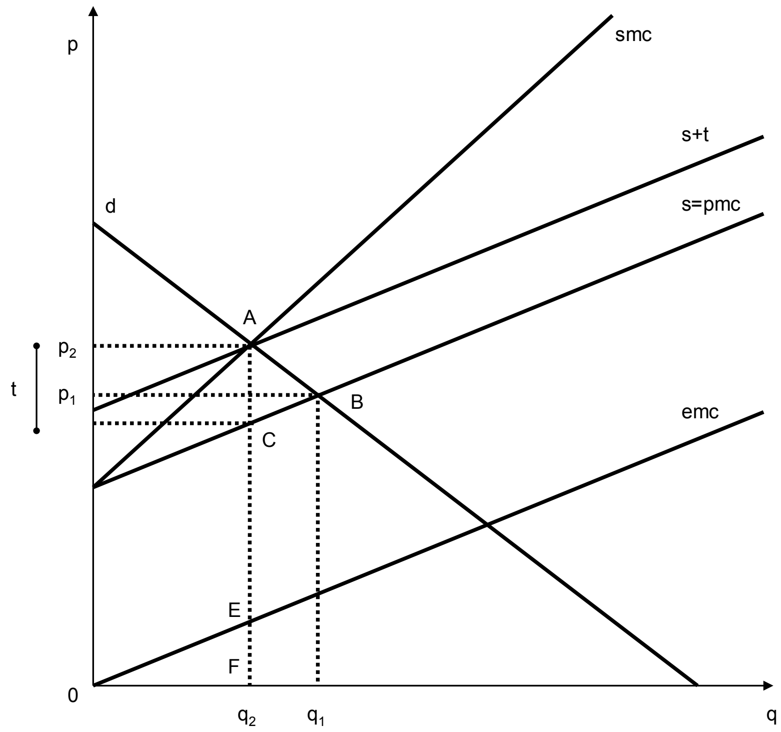

Figure 3.2: Pigou taxation

Pigou shows a perfect solution in theory. Unfortunately, extensive information requirements are crucial for decision makers to calculate the optimal tax rate correctly. Whereas external additional costs are assumed as given in the model, they can only be approximated in reality. For example, many environmental damages occur after a considerable time lag. Furthermore, the number of pollution origins and claimants are usually very high. In many cases it is not possible to attribute external effects correctly to their causer. Moreover, the fixed tax rates only work for one specific constellation of supply and demand so that the governmental authority would permanently have to re-evaluate and adapt the taxes rates. These and other problems are a major barrier for the use of the Pigou taxation in praxis (Fritsch, Wein, Ewers, 2003, p.124-125).

3.2.2. Internalisation by negotiations (Coase-Theorem)

The next noticeable step followed in 1960. Ronald Coase recognised the unambiguous assignment of property rights to be the key to an efficient internalisation of external effects (Rudolph, 2005, p.25). Property rights are devices of the society to regulate laws, conventions and customs (Jaeger, 1993, p.54). Operating rights always imply a governmental authority that enforces these rights. A right is only as secure as it is the duty of people to accept the regulations. Therefore, to internalise external effects, the state needs to create stable institutional basic conditions. This enables an efficient management of environmental resources as private goods.[9]

The importance of property rights is also shown by the endowment effect. This hypothesis, developed by Richard Thaler in 1980, indicates that people value a good more, once their property right to it has been established. In other words, people put a higher value on objects they own compared to other objects.

The assignment and design of individual property rights on resources have a direct impact on the economic achievement of a society because they determine the incentives for economic subjects to internalise external costs. When property rights are fully specified, they can be allocated efficiently through negotiation or trading, without the need for a superior authority. The resulting situation is independent of the initial allocation of property rights (Rudolph, 2005, p.25). Coase argues that the appearance of external effects is not only due to a physical causer but also to the existence of one or more persons concerned. Unlike Pigou he distinguishes between physical and economical responsibility and refers to the reciprocity of the externalities problem. In many cases it is not clear which party causes the external costs. The only clear fact is that external costs occur because of competing requirements of the same natural resource. This competition transforms the initially free environmental good into an economic good. But who has to pay for the utilisation depends on the effective legislation of property rights (Jaeger, 1993, p.39-40).

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[9] The economic problem of the absence of property rights was already described in the 18th century by David Hume in his book "A Treatise of Human Nature", today commonly known as "the tragedy of the commons".

In the absence of legal liability, the emitter is entitled to cause boundless social additional costs. He will only agree to decrease the damage against payment of some compensation.[10]

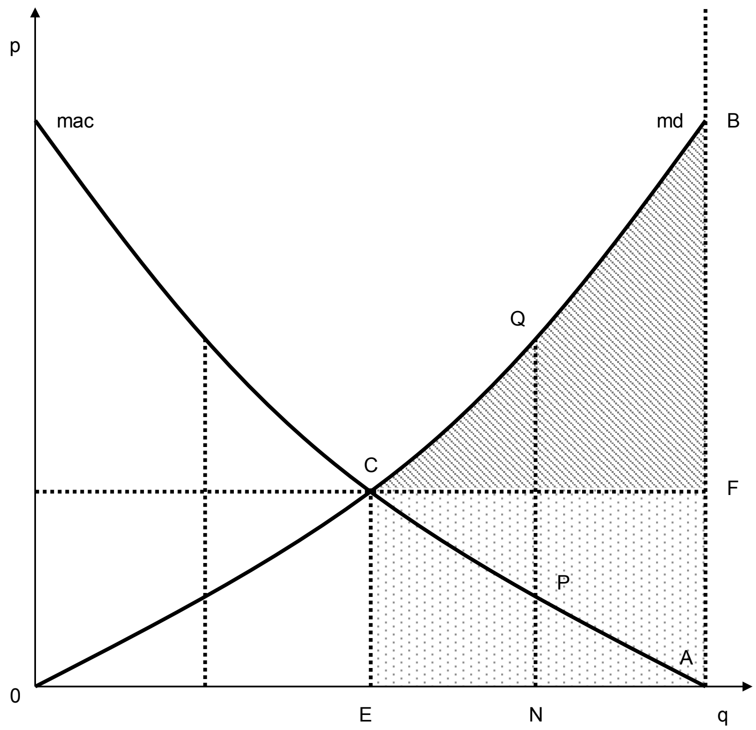

Figure 3.3: Coase-Theorem – Absence of legal liability

The point of origin in our consideration is 0A in figure 3.3 (based on Fritsch, Wein, Ewers, 2003, p.135). The polluter and the claimant both have an incentive to attend negotiations about the extent of the damage. The claimant could increase his benefit by transferring some payment to the emitter to make him reduce his harmful behaviour. On the other hand, the polluter generates a benefit if this compensation exceeds his abatement costs. If the damage quantity is reduced to 0N, the area QBAN shows the damage reduction experienced by the claimant. Because this area exceeds the costs of abatement (PAN), a Pareto improvement with regard to the allocation is still possible. Negotiations continue till the difference between the

[10] In his paper „The problem of Social Cost", Coase used the example of a farmer and a cattle-raiser operating on neighbouring land to demonstrate his ideas figuratively. Ronald Coase was rewarded with the Nobel Price in Economics in 1991 for his contribution of discovery and clarification of transaction costs and property rights.

abatement costs and the pollution benefits equals zero. This situation is reached at the point 0E.

Therefore, the claimant transfers an amount CE for every pollution unit to the emitter. This agreement is advantageous for each party. Compared to the initial situation (given by the pollution amount 0A), the emitter increases his benefit by the area ACF. This is calculated by subtracting the accumulated compensation (given by the area ECFA) from the abatement costs (ECA). The benefit of the claimant increases by the area CBF since he reaches benefits of the area ECBA but has to pay compensation costs, given by the area ECFA. So the agreement increases the macroeconomic benefits by the area CBA, the sum of the benefits of the emitter and the claimant. Figure 3.3 is just one of many possible solutions of how the welfare gain can be distributed among the involved parties. The concrete realization depends on negotiation skills and power.

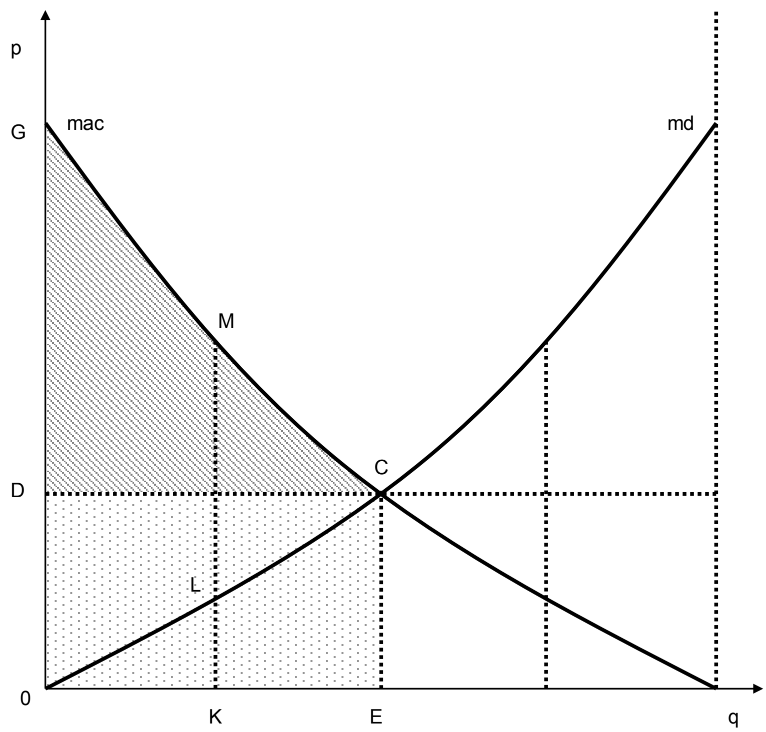

Figure 3.4: Coase-Theorem – Legal liability

In a situation with legal liability, shown in figure 3.4 (based on Fritsch, Wein, Ewers, 2003, p.136), the generation of external costs is generally forbidden. However, potential emitters have the possibility to buy pollution rights. The claimant will only agree if the originated damage is at least compensated. Starting from a situation without environmental damage (point 00), there are incentives for negotiations till the marginal abatement costs equal the marginal damage. This point is reached at an emission quantity 0E. If the parties agree upon a payment of the extent of CE by the emitter, the benefit of the polluter increases by the area DGC while the claimant gains benefits given by the area 0DC. The macroeconomic gain of welfare adds to the area 0GC.

As shown, both legislation regimes lead to negotiations that enable the parties to move towards common as well as individual profit maximisation step by step. Both situations finally result in a social and macroeconomic Pareto-optimal allocation of resources. The arrangement of the initial distribution of property rights appears to be neutral according to the damage quantity, at least in theory. The macroeconomic optimum is reached through decentralised decisions without the need of a governmental authority. Of course, unlike the allocation result, the distribution of profit and income is a matter of the prevalent legislation system.

How technological external effects can be internalised through private negotiations is a matter of a variety of factors. Inevitable preconditions are the existence of freedom of contract and the unambiguous allocation of property rights. For the practical use of the Coase-Theorem transaction costs have to be considered. In general, if the transaction costs are distributed disproportionally among negotiation partners, the one party that faces higher transaction costs is disadvantaged. One major determinant of transaction costs is the number of concerned persons. Generally, costs for organising a special interest group increase disproportionately with the number of involved participants (based on Fritsch, Wein, Ewers, 2003, p.138). Furthermore, the free rider problem tightens. One possible solution for this problem is that the participants assign their right for negotiation to a representative. These problems show that the internalisation through negotiations is only theoretically an appealing solution, in reality it is connected with serious problems. Thus, it is only a possibility in exceptional cases.

3.2.3. The standard-price-approach

Neither the Pigou tax nor the Coase Theorem can be easily applied to practical politics. Thus, economists were still looking for applicable concepts to efficiently internalise negative external effects and for environmental policy-making. In the year 1971, William J. Baumol and Wallace E. Oates developed the standard-price-approach. Its purpose is to achieve a politically defined environmental standard (fixed target policy) with the lowest costs possible (Rudolph, 2005, p.25-26). Assessment base is the physical degree of damage or a factor that is closely associated. Thus, negative external effects are reduced efficiently and technical progress is stimulated that helps to avoid future damage. The general idea is that the government collects a fee for environmental utilisation. The economic player then chooses to pay the fee or to reduce the intensity of environmental contamination.

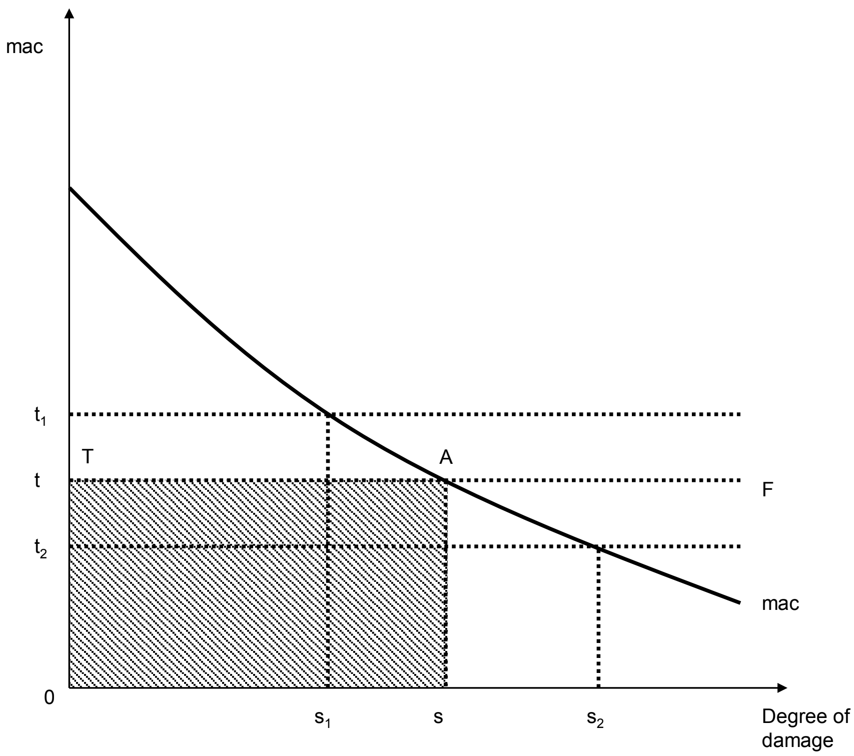

Figure 3.5: Standard-price-approach

In figure 3.5 (based on Fritsch, Wein, Ewers, 2003, p.126) the tax rate exceeds the marginal abatement costs of all pollution units additional to the point 0S. The optimum appears at point A (t=mac). Here, the tax rate and the marginal abatement costs are equal. At the tax rate t, the polluter produces damage of the degree 0S, and he has to pay a tax amount shown by the rectangle 0TAS. The increase of the tax rate from t to t_1 leads to a reduction of the damage quantity to $0S_1$, whereas in the case of a decrease from t to t_2, it is economically rational to avoid less damage. The optimal situation then moves to the quantity $0S_2$. This mechanism leads to an overall cost-efficient allocation of actions for emission avoidance.

In summary taxation according to the standard-price-approach is a practical realisation of the Pigou solution. Unfortunately, in terms of accuracy the approach faces major problems. To correctly determine the appropriate tax rate, the governmental authority needs abatement cost functions of all emitters, which in reality can only be approached in the long term by trial and error. Alterations of the number of emitters, availability of new production technologies and price changes additionally decrease the accuracy of the standard-price-solution and create the need for adjustment over time.

3.2.4. The Clarke solution

In practice, the assumption of perfect information can hardly be applied at all. Therefore, the Pigou taxation and the Coase Theorem both lead to inefficient results regarding production quantities and welfare distribution. Using the Clarke taxation this deficit can be eliminated.

Firstly, a neutral authority fixes the microeconomic production optimum. In figure 3.6 (based on Jaeger, 1993, p.52) this quantity is given by q_0. The emitter as well as the claimant have to announce how the pollution quantity shall be diminished compared to the uncorrected competition equilibrium. The idea behind this internalisation concept is that both parties have to discharge a Clarke-taxation. The emitter pays a tax rate t_E which exactly equals the external marginal costs of the claimant. The affected party, as causer of the production reduction, also pays a tax t_B that is equal to the marginal abatement costs of the emitter. None of the participating actors has any rational incentive to reveal their true preferences.

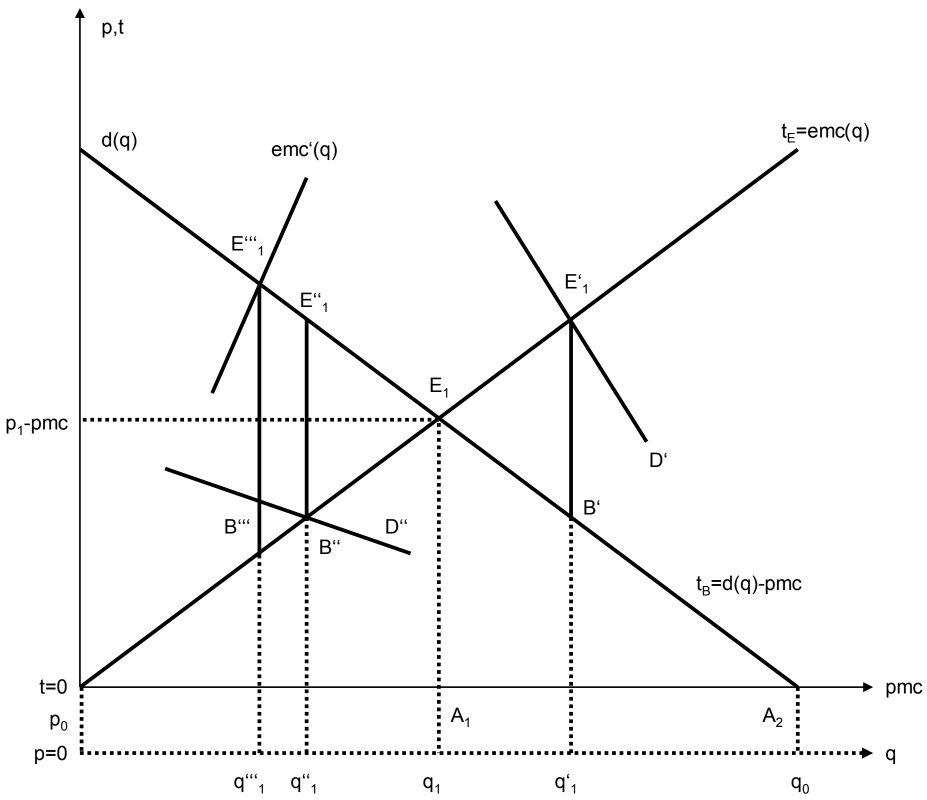

Figure 3.6: Clarke solution

The emitter will advocate the production quantity where the tax amount for the last produced unit t_E=emc(q) exactly equals the additional rent of production d(q)-pmc. This microeconomic production optimum is located where the emc and the d curve intersect and accounts for q_1. If the emitter pretends an incorrect demand curve d', his marginal tax rates exceed the marginal profit, shown by the distance E_1'B'. In the case of d'', the marginal benefit loss exceeds the marginal tax saving by E1''B''. The claimant also favours the production quantity q_1 because at this amount the marginal taxation as compensation for production limitation $t_B(q_1)$ exactly matches the external marginal costs burdening the emitter emc(q_1). By pretending emc'(q), the marginal taxation would exceed these external costs by E''$_1$B''. Therefore, also in the case of the claimant microeconomic and macroeconomic interests harmonise. The total tax revenues of the state add up to

$$T = \int_0^{q1} emc(q)dq + \int_{q1}^{q0} [d(q) - pmc(q)]dq$$

The principle of double taxation developed by Clarke faces similar problems as the Pigou and Coase arrangements, but at least it solves the problem of strategy sensitivity. Of course, the tax collecting authority needs to know the demand curve as well as the curve of external marginal costs. Otherwise, the achieved intersection will not be a Pareto-optimal welfare and allocation result.

3.2.5. The invention of tradable permits

In the year 1968 the Canadian political economist John H. Dales developed a system of tradable emission permits. Like Coase he blamed the absence of property rights for the occurrence of external effects, like Baumol and Oates he constrained his approach to cost efficiency (Rudolph, 2005, 26-27). The internalisation of external effects using tradable permits can, therefore, be interpreted as a combined realisation of elements of the Coase-Theorem and the standard-price-approach (Fritsch, Wein, Ewers, 2003, p.139). In his model private property rights on public goods can be created by privatising theses goods through the definition of unambiguous exploitation rights and by making these rights accessible to the pricing mechanism. This is done by the creation of a market for emission licences.

Generally, two different types of emission licence systems are possible (Perman, Ma, McGilvray, Common, 2003, p.223). In the cap-and-trade system (described in detail in the following chapters), the politically determined total quantity of emissions is segmented into a plurality of fractions and then allocated among potential emitters. Polluters then choose to use their licences themselves or to sell their permits on the licence market. This procedure avoids the need for regulation adjustments that are necessary in the standard-price-approach because the total quantity of emissions is directly determined by political decision-makers and not subjected to the market development. Another alternative is the emission reduction credit. Here, a business-as-usual scenario is used to estimate a baseline profile of relevant emissions. By emitting less harmful substances than estimated, a company earns a corresponding amount of emission reduction credits. Each credit then works as a transferable emission permit (Perman, Ma, McGilvray, Common, 2003, p.228).

Tradable permit are usually judged very positively in economic literature, but they pose multiple practical questions and problems. Therefore, for a long time permits were hardly used in practical politics (Altmann, 1997, 137).

4. Theoretical analysis of the licence solution

As mentioned in chapter 3.2.5, the tradable permits solution is usually judged very positively in economic literature. On the other hand, the practical establishment of an emissions trading system raises many delicate practical challenges. Chapter 4 analyses the most important strengths and weaknesses of the certificates solution and discusses its theoretical functionality.

4.1. Functionality of the tradable permits solution

The commitment to maximal values for environmental pollution is a political process. After this decision, the certificates are allocated among potential emitters and a market for emission licenses emerges. In the upcoming chapters, the theoretical functionality of trading with emission permits is taken under scrutiny.

4.1.1. The commitment to maximal values for regional environmental pollution

The licence solution functions like a cap-and-trade system. The policy maker determines an acceptable upper limit of pollution for a specific environmental subject in a geographic area. This decision determines the total emission volume. Control variables can be either emission- or extraction data or indirect indicators like production or input values. The use of direct regulation requires sufficient knowledge about macroeconomic abatement- and consequential costs and regeneration functions of environmental resources. Moreover, for the execution of the indirect regulation system, aggregate production-, emission- and diffusion functions are needed. This leads to barely solvable problems of information provision (Jaeger, 1993, p.328). Furthermore, considerable transaction- and administration costs appear as an outcome of strong requests for supervision and control of the effectively executed emissions.

Ideally, regional contamination and benefit standards are determined according to economic optimality criteria. This means that total economic costs are minimised. As figure 4.1 (based on Jaeger, 1993, p.330) shows, total emission costs (ec) are composed of aggregated abatement costs (erc) and aggregated consequential costs (ecc). The minimum of the total costs is given by

$$ec^*(e^*) = Min!\left[erc(e) + ecc(e)\right]$$

The cost minimum is reached at the emission quantity e*. At this point the macroeconomic marginal emission reduction costs (merc) equal the macroeconomic external marginal consequential costs of emissions (mecc). The macroeconomic marginal abatement costs are calculated by aggregating all microeconomic marginal abatement costs.

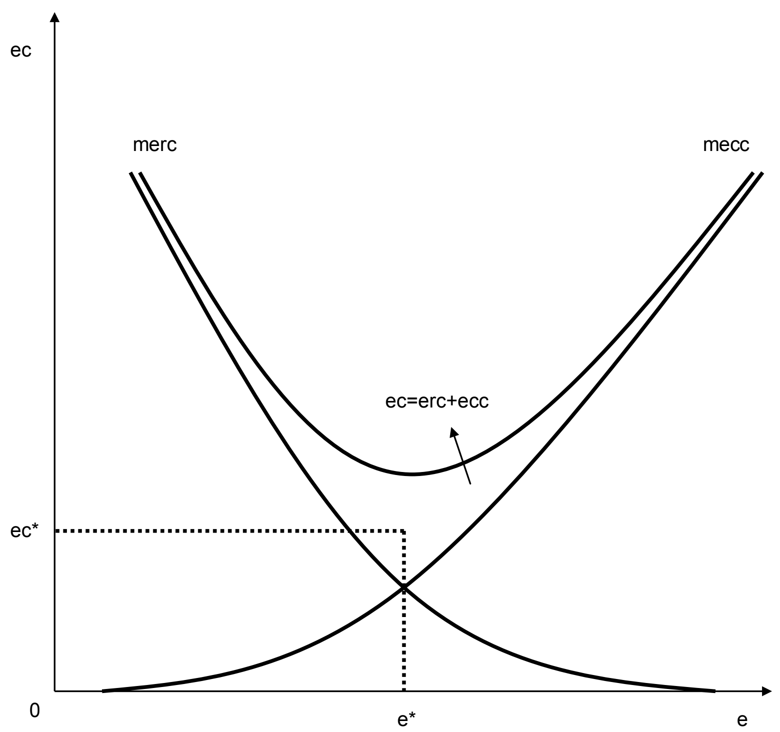

Figure 4.1: Macroeconomic optimal emission standard for a specific region

Economic optimisation is only possible in a world that is characterised by perfect information. In reality asymmetric information is provided, especially regarding regional consequential costs. The administrative authority has to approach the efficient marginal utilisation values through trial and error, which leads to uncertainty among involved actors. Another possibility is to agree upon a biologically maximally tolerable emission value and periodically deviate the marginal emission values for a given region. Of course, political decision-makers also consider other objectives than efficiency, including health and safety considerations, provision for equity, sustainability, and technical as well as political feasibility (Perman, Ma, McGilvray, Common, 2005, p.193). Because the political process might generate arbitrary results, this procedure can lead to suboptimal solutions (Jaeger, 1993, p.331).

Initially, the mandate owner of the environmental good is a governmental authority or the state itself. The total emission quantity is then segmented into separate parts and certified as emission licences. In the next step, these licences are distributed among potential emitters. The ownership of a certificate entitles the occupant to the use of a certain pollution quantity during a given timely scope inside a local territory. After the distribution of the licences they can be assigned from one owner to another – a market for emission licences develops. The price and the allocation are determined endogenously by supply and demand so that the price shows the scarcity of the environmental resource.

4.1.2. Supply of environmental certificates

The government controls the macroeconomic supply of environmental permits as a monopolistic supplier. It can auction the licences on an environmental stock market or distribute them for a fixed price or even for free among established emitters.

In the case of licence auctioning, a primary market is generated that determines a first price. The problem of auctioning is that a completely new legal situation is created. The right of continuance as well as all permissions that are assigned up to this date are not reliable anymore. Furthermore, financially strong corporations might try to displace smaller companies from the market (Altmann, 1997, p.138).

Another possibility is the allocation free of charge. The market then develops through licence assignments among polluters. This alternative is called the grandfathering method (Altmann, 1997, p.138). If permits are distributed cost-free, the criteria chosen for the allocation process have to be emissions generated in the past. Otherwise companies would have an incentive to pretend that their present emissions are exorbitantly high to receive huge certificate quantities.

Free distribution of licences discriminates non-resident enterprises and tends to disadvantage corporations that already invested in environmental technology before the base period ("rewarding the laggards"). An easy way to attenuate this problem is to choose a base year dating back a longer time. Furthermore, the danger exists that new entrants are disadvantaged compared to already existing firms. This problem is usually confronted by setting aside contingents for new market entrants. Of course, this solution in turn endangers the environmental effectiveness.

Because emission permits are certified and transferable, they are traded on the secondary market, irrespectively of the initial allocation method. On both markets, buyers can be either established and potential emitters, or any actors such as private persons or environmental protection organisations. In the latter case, there is the possibility that additional actors decrease the total supply and, therefore, lower the emission quantity in a given region.

Time limitation on licence validities enables the governmental authority to control the reduction or increase of the total licence quantity after the expiry of a given period. In the case of unlimited permits, the government has the possibility to devaluate the certificates or to use open market operations to decrease the emission quantity.

4.1.3. Demand of environmental licences

Established as well as potential emitters in a certificate regime have the alternative to either continue or intensify their environmental utilisation by buying and executing an adequate number of usage permits, or to abridge their emissions. Emitters will choose their emission quantity so that their total costs, that consist of reduction costs and the acquisition of certificates are minimised. For this predictable behaviour several assumption are necessary. Decision parameters like expectations about future economic and environmental developments must not be relevant. Furthermore, emitters have to possess adequate information and must not act strategically. In this situation emissions will be reduced so that the individual total marginal cost of emission reduction is equal to the certificate price, which can be interpreted as the marginal cost of the emission (Jaeger, 1993, p.335). Of course the assumptions listed above are far from realistic.

The individual marginal cost functions for emission reduction can be interpreted as demand curves for emission benefits (Jaeger, 1993, p.335). The total demand in a region can be determined by horizontal aggregation of all individual demand curves. If the licence price increases because of a decline of total supply, certain demanders will reduce their emissions by reducing production or by substituting for cleaner resources, production processes or products. Furthermore, under dynamic conditions the demand curve for emission licences can alter its form or position, for example, because of an increasing number of emitters, product and process innovations or because of new environmental protection technology.

4.1.4. The interaction of supply and demand in the case of certificate auctioning

Let us consider a functioning certificate market. During the initial allocation a starting certificate price p is generated that balances total demand and total supply. In the ideal case, market clearing makes the marginal utilisation cost reductions equal the marginal costs of environmental utilisation, namely the permits' market price. Through the market process, the certificate solution achieves the environmental target in an economically efficient way. In the market equilibrium the system leads to a microeconomic efficient allocation of environmental utilisation, minimising the macroeconomic emission avoidance costs.

Another question is if the certificate solution leads to an economically optimal pollution quantity straightaway. This depends on whether the state authority is able to achieve and politically enforce the economically cost-minimising emission standard. On this very unlikely assumption, the society would already reach a microeconomic as well as a macroeconomic equilibrium on the primary market, and, therefore, a society-wide Pareto-optimal environmental protection solution.

In reality, the market is very unlikely to quiet permanently after the initial allocation. Various troubles lead to continuous market imbalances which require ongoing adjustment processes. Furthermore, on a non-regulated secondary market, the supply curve is not necessarily vertical and, therefore, not totally price inelastic anymore (Jaeger, 1993, p.340). The free market entrance of non-emitters enables other actors than the state to appear as buyers on the secondary market and to delete emission permits. Two possibilities are conceivable. Rationally acting non-emitters will orient their behaviour towards the benefits that the acquisition and abandonment of environmental permits generate. Let us assume that the initial certificate allocation of the total emission licences quantity el_1 generates a certificate price p_1 in figure 4.2 (based on Jaeger, 1993, p.341).

As long as the certificate price p_1 is less than the marginal consequential costs of polluting activities $mecc(e_1)$ incentives for non-emitters remain to bear these consequential costs and to put utilisation licences out of service. This process continues until the macroeconomic optimal emission status e_1 ($=el_1$) is reached. The price per licence, therefore, increases to p_1*. The macroeconomic adjustment process terminates when the last saved consequential costs equalise the certificate price. This means that under ideal conditions the supply curve on the secondary market is represented by the curve of marginal consequential costs.

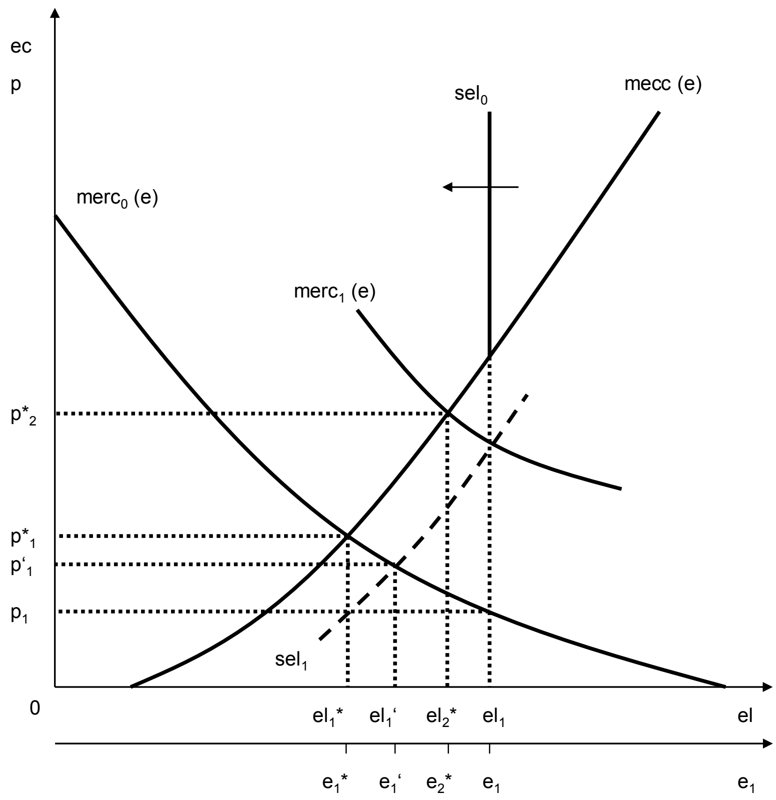

Figure 4.2: The long-term price building process on the secondary market

Unfortunately, the assumptions necessary for this results (non-emitters have to act rationally, all actors possess perfect information and no strategic behaviour and no non-economically justified budget constraints appear) (Jaeger, 1993, p.342) are very unrealistic. The less these requirements are met, the more the certificate supply curve and the curve of marginal consequential costs differ from each other and, therefore, the more considerably the realised degree of environmental utilisation differs from the economically desired cost-minimal standard.

It is possible that a connection between different environmental utilisations appears. Harmful substances can be connected as complements or substitutes. In the first case, it is sufficient to introduce licences for only one kind of emission, in the latter case, the state authority has to include all substances in the permit solution.

4.1.5. The interaction of supply and demand in the case of a rationed certificates market

Another possibility is to ration certificates and distribute them for a fixed tariff lower than the market price or even for free. The total quantity of environmental utilisation is restricted to a standard lower than the status quo. Certificates are allocated among the established actors proportional to the emission distribution at any time before the system change. The reallocation process is a result of the secondary market. Enterprises with relatively low abatement costs sell their certificates which are no longer required on the emission market. Corporations that face high abatement costs demand those permits. This process continues till the market is cleared and no actor can upgrade his situation anymore. In a well-functioning competitive market, the licence price is identical to the one generated initially from auctioning permits (Perman, Ma, McGilvray, Common, 2005, p.225). The trading process leads to a microeconomic Pareto-optimal result. In succession, the market functions the same way as in the auctioning case.

The environmental authority also has the possibility to adopt the status quo standard and gradually reduce the cap on the secondary market. This can be done by using either devaluation- or open market operations.

4.2. Theoretical device analysis

The license solution is characterised by many great advantages, especially cost-efficiency. Of course, this attribute is dependent on important preconditions like perfect information of all actors and low transaction and administration costs, which are discussed in the following chapter. Furthermore, the ecological effectiveness of the permits solution and the problem of regulative compliance are also analysed.

4.2.1. Economic efficiency of the tradable permits solution

The greatest benefit of the tradable permits solution compared to other policy measures for environmental protection is cost-efficiency. The following example sketches a permits market and shows the difference compared to a regulative solution. In addition, this chapter explains the advantage of dynamic efficiency and discusses the relevance of transaction and administration costs.

4.2.1.1. Example of a permits market

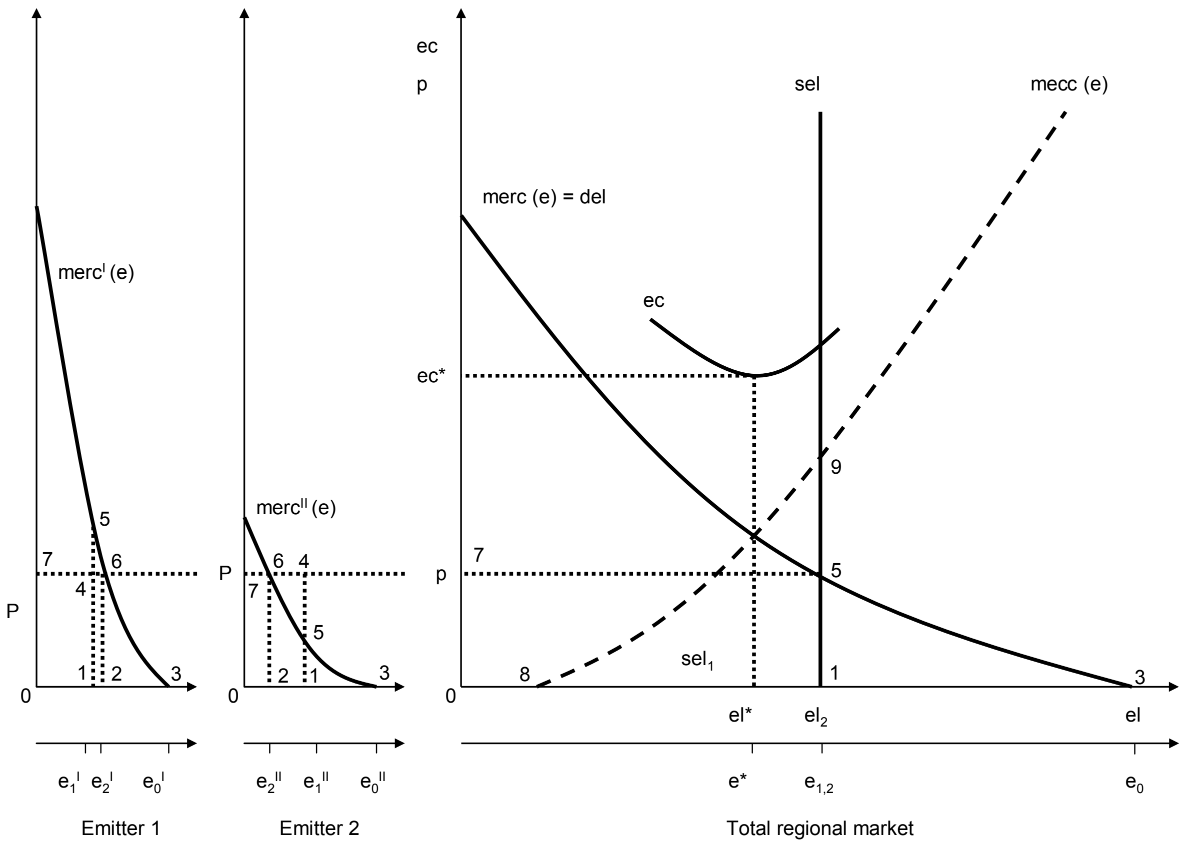

Figure 4.3: The price- and quantity building process on the primary market

Figure 4.3 (based on Jaeger, 1993, p.337) shows a regional market with n emitters, two of which are illustrated in the figure. Without a tradable permits system it is unlikely that emitters will reduce their environmental damage. In this initial case the environmental burden equals

$$e_0 \leq e_0^I + e_0^{II} + \ldots + e_0^n = \sum_{t=1}^{n} e_0^i$$

Let us assume that the environmental protection authority decides to reduce the environmental damage by exactly half, to e_1. This is done by ordering every emitter to reduce his emission activity by 50%. In this directive regime the total macroeconomic emission reduction costs add up to:

$$\sum areas(1,3,5)^i \succ area(1,3,5)$$

The same environmental target can be reached through the implementation of a licence concept in an economically more efficient way. After the initial allocation, a certificate price p is generated. The emitters react diversely according to their microeconomic optimisation calculus. In figure 4.3, emitter I will reduce his pollutant activities only to e_2^I and buy the remaining necessary permits whereas emitter II is able to sell parts of his licences by reducing his emissions to e_2^{II}. In the market equilibrium a microeconomic efficient allocation of environmental utilisation is generated. The macroeconomic costs of emission avoidance are minimal and, therefore, smaller than using the directive regime.

$$\sum areas(2,3,6)^i = area(1,3,5)$$

In addition, the expenditures of the emitters for the purchase of the emission certificates equal

$$\sum p * el_2^i = p * el_2$$

The total expenditures of the emitters are shown by the areas $(0,3,6,7)^i$. The revenues of the state generated by the sale of the licences, account for $p*el_2$, of course optional transaction- and administration costs have to be subtracted.

4.2.1.2. Theoretical background

Efficient environmental policy is characterised by the attainment of a given quality target which is subject to minimal economic expenses (Rudolph, 2005, p.34). The allocation of actions to reach the quality target is efficient if the sum of all abatement costs of all emitters is minimal. In the permits solution case, emitters will choose an optimal emission quantity at which their marginal abatement costs equal the price of the certificates. Through microeconomic calculation also follows that the society-wide target achievement is cost-efficient. At a given cap emitters with high abatement costs buy more licences but avoid reducing their emissions. Emitters who face lower abatement costs demand less licences but they amplify their actions to avoid emissions. Therefore, reductions only take place at cost-optimal locations. Formally economic analysis says that the sum of all abatement costs of all emitters is minimal if, and only if, the marginal abatement costs of all emitters are equal. This conclusion is known as the least-cost theorem of pollution control (Perman, Ma, McGilvray, Common, 2005, p.204). Irrespectively of the initial allocation method, the licence solution achieves this adjustment of abatement costs of all emitters and, therefore, leads to a society-wide cost-minimal environmental protection (Rudolph, 2005, p.37).

Competitive characteristics play a significant role concerning the problem-solving ability of licence solutions. Retention of licences to influence the market situation of competitors through market power leads to market distortions and, thereby, to efficiency losses. New emitters could be deterred from entering the market. However, facing heterogeneous markets, this strategy is hardly efficient. Furthermore, governmental supervision would solve the problem.

In both, the environmental taxation and in the tradable permit solution, emitters try to minimise their costs. The major difference between these two alternatives is that in the first case the price for emissions is fixed centrally and the market determines the emission quantity whereas in the case of emission certificates the total quantity is fixed and the price development depends on the market mechanism. That is why the tradable permit solution is called a quantity solution while environmental taxes are said to be price solutions (Altmann, 1997, p.138).

The implementation of the certificate solution alters the income and wealth situation of the involved participants. Temporarily limited licences lead to a redistribution of disposable incomes while unlimited permits have an impact on the distribution of wealth. Furthermore, the initial allocation system alters distribution effects. In the case of auctioning permits, the emitters have to face both the costs for emission reductions from a possibly higher initial position to the permitted emission quantity as well as costs for buying the required permits on the auction market. In the case of cost-free initial allocation, on the other hand, this inclusion of leftover pollution costs omits. The charging of costs determines to which degree the licence solution matches the costs-by-cause principle (Rudolph, 2005, p.39). In the end, it is always the allocation impacts that decide about the ability of political enforcement.

If the information conditions are good, the licence solution will more likely lead to a microeconomic and macroeconomic optimal and cost-efficient allocation result. In spite of this, the certificate solution is not totally independent of market dysfunctions. Repeated unheralded devaluations or open market interventions lead to uncertainty and complicate expectations and planning. There is also a danger that speculators buy environmental certificates to hoard them and sell them later for profit. Furthermore, mighty companies could run short licences to constrain new suppliers to enter the market. There are various actions, the environmental protection agency can undertake, to undermine these anticompetitive methods and facilitate the expectation creation and planning of the economic subjects. A first method is to restrict the validity of the certificates. At an early stage, the authority can also announce a graduate scheme that amplifies the transparency of the overall certificate supply. A possible reaction to anticompetitive strategies of market leaders is to enhance the certificate supply on a short notice (Jaeger, 1993, p.357). Of course, any kind of market regulation impairs the adjustment and allocation process considerably, which is reflected in macroeconomic suboptimal results.

4.2.1.3. Dynamic efficiency

In a certificate system, every actor aims independently at an individual solution by considering abatement- and certificate costs. Thus, instead of only minimising costs given the actual technology conditions companies, face huge incentives to develop and implement new environmental protection techniques in the production and process area. This system leads to a decline of average and marginal abatement costs.

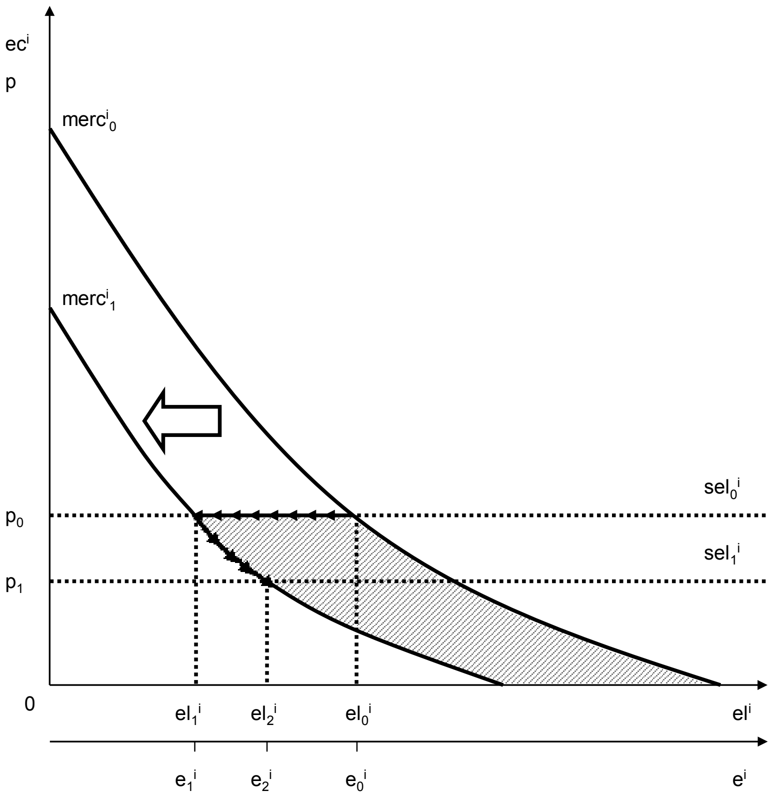

Figure 4.4: Dynamic incentives of a certificates solution

As long as the certificate price stays at p_0 in figure 4.4 (based on Jaeger, 1993, p.361), incentives are strong for invention and innovation. By reducing their emission quantity from e^i_o to e^i_1, emitters save costs through reduction activities (illustrated by the shaded area) as well as through the acquisition of certificates (at first: $p*(el_0^i-el_1^i)$. Even if other actors imitate the new technology, a sustainable advancement would remain. This process leads to a macroeconomic reduction of the demand of licences and, therefore, to a common price decline from p_0 to p_1. Realistically, this development makes the environmental protection agency permanently cut back the certificate supply which improves the ecological quality sustainably. The positive circular conjunction between economic growth, the advancement of environmental quality and technological innovation creates an extraordinarily dynamic efficiency of the certificate solution. The incentives given by the licence solution make economic growth at constant or even decreasing environmental contamination plausible.

Another major advantage is the possibility to administer certain parameters, like the initial quantity, the time limitation of permits, and the gradual utilisation cutback, flexibly. Therefore, fast and differentiated reactions on market and technology adjustment processes are possible.

4.2.1.4. Transaction and administration costs

Analysing the tradable permit solution, both, the initial assignment of licences from the state to enterprises and the transfer of licences among emitters, are considered transactions[11]. Market based transactions cause costs that can shift the supply and demand curves and therefore have an impact on the equilibrium. If the transaction costs are greater than the efficiency gains of a decentralised coordination of individual plans through the market, other coordinating mechanisms could generate cost advantages compared to the market. (Rudolph, 2005, p.53)

Unlike the state, emitters have detailed knowledge about internal production processes, corporate singularities, local characteristics, and available human capital. Emitters, who are in possession of this specific knowledge, are able to decide on the best abatement strategy. Because an emitter has to face the consequences of his decisions himself, he will use his knowledge in an efficient way. This leads to an optimal usage of the knowledge potential (Rudolph, 2005, p.54-55).

Transaction costs reduce the quantity of licences traded. The existence of transaction costs constrains the trading of licences and, therefore, obviates a society-wide efficient allocation of abatement actions. Transaction costs can be diminished through the installation of licence stock markets and the usage of brokers. Furthermore, increasing market activities and frequent transactions automatically

[11] According to Rudolph, transactions are interactions of economic subjects to whom property rights are assigned. In general, the execution of transactions is not cost-free which influences the decision-making of economic subjects.

generate information that helps to diminish market uncertainty, lower transaction costs and, in turn, increase activity on the licence market.

Administrative costs strongly depend on the concrete practical design but tend to be lower in the case of a licence solution than in the case of other environmental policies (Rudolph, 2005, p.40). Costs which are implemented in advance are low because market-oriented instruments avoid a complex single approval procedure. Only the total quantity of licences is given as a result of political determination. Ex post, the expenses of control and supervision are comparable to a requirement system.

4.2.2. Ecological effectiveness of the licence system

Ecological effectiveness measures the degree to which an environmental instrument is able to unerringly achieve the politically appointed quality target (Rudolph, 2005, p.43). Using pollution licences, the environmental burden can be actuated directly through the determination of a total emission quantity. The boundary of environmental exploration through the state as the ambassador of the society matches the justifiable claim of each member of the society for an acceptable environmental quality standard. What is more, the licence solution participates in the intergenerational equitableness. The boundary of the total quantity of emissions acknowledges the boundary of the ecological system.

The compliance of environmental quality targets cannot be disturbed by the market process. The achievement of intentions is independent of the number of actors as well as of the demand elasticity (Jaeger, 1993, p.356). On the assumption of functioning licence markets, the entrance of new market participants is possible without environmental challenges. The burden on the environment does not change, only the price for licences increases. Therefore, the environmental contamination cannot legally exceed the fixed value. It is the responsibility of the state to set the environmental target and to supervise the compliance. Knowledge about abatement cost functions is not necessary.

The time period to reach the environmental target can be chosen freely, according to the economy and the urgency of the situation. An essential problem of the licence solution is the creation of “hot spots”. In separate regions specific contaminants could appear in concentration, leading to high local burden. Possible solutions are additional regional limiting values (back-stop regulation) or the creation of regional markets. This, in succession, can lead to a diminishing of market participants and, therefore, to thin markets (Rudolph, 2005, p.46). Another solution possibility is the differentiation of licences.

The more information about consequential costs of environmental utilisation the agency has, the better is it able to aim the environmental quality standards. Unfortunately, data can be updated only with a considerable time lag; therefore interventions tend to lead to suboptimal results (Jaeger, 1993, p.358).

Another central question is to what extent the licence solution meets the requirements of the precautionary principle. Environmental decisions should be swayed so that potential future environmental dangers are avoided a priori in order to protect the natural livelihood (Rudolph, 2005, p.47-47). This leads to an economic as well as an environmental advantage. The licence solution discharges a fundamental alteration of the valuation of the environment in the long term. Furthermore, corporations face a permanent incentive for innovation.

4.2.3. Regulative compliance

Concerning the regulative compliance, the certificate solution hardly gives cause for concern. Even so, in the case of the initial allocation by auctioning licences as well as regarding a cutback of utilisation rights later on, the question of a problematic reduction of vested rights in accordance with the rule of law remains. Factual utilisation rights of economic actors are undone by the realignment of property rights; individual pollution holdings are narrowed and redistributed. It is a violation of the principle of equity and good faith if legally warranted vested rights are affected without any legal background (Jaeger, 1993, p.353-354).

The administrative allocation also bears the risk of arbitrariness regarding the fixation of individual contingents. Furthermore, the unequal treatment of established corporations and newcomers is not only problematic from a legal but also from an economic perspective. A more philosophic point of criticism is the question of the ethical defensibleness of the commercialisation of the environment. By applying the certificate solution, the right on environmental exploitation is at least bounded.

5. The European Emissions Trading System

The European Emissions Trading System was established in 2005 to help the member states of the European Union to reach their reduction and limitation commitment. The upcoming chapter sketches the development of the EU ETS and explains its practical functionality in the first two trading periods as well as planned alterations for the third trading period.

5.1. Development of the EU ETS

The Kyoto Protocol obligates industrialised nations to jointly reduce their greenhouse gas emissions by 5% compared to 1990 levels in the time period between 2008 and 2012. As specified in Annex B of the protocol, the reduction targets vary among countries due to different national circumstances. The European Union took a front-running position in the climate protection negotiations and finally agreed to jointly reduce its greenhouse gas emissions by 8% compared to 1990.

In the Burden Sharing Agreement of 1998, the member states of the European Union decided to make use of Article 4 of the Kyoto Protocol (the "bubble concept") and share the reduction target among the community[12]. These individual reduction obligations are shown in figure 5.1[13]. The commitments are very unequal because

[12] If the 8% target is collectively achieved, it does not matter if individual countries within the EU miss their particular targets.
[13] http://www.eea.europa.eu/data-and-maps/figures/kyoto-burden-sharing-targets-for-eu-15-countries, downloaded on June 11, 2010.

the member states are in different stages of development, they range from -28% in Luxemburg to +27% in Portugal[14].

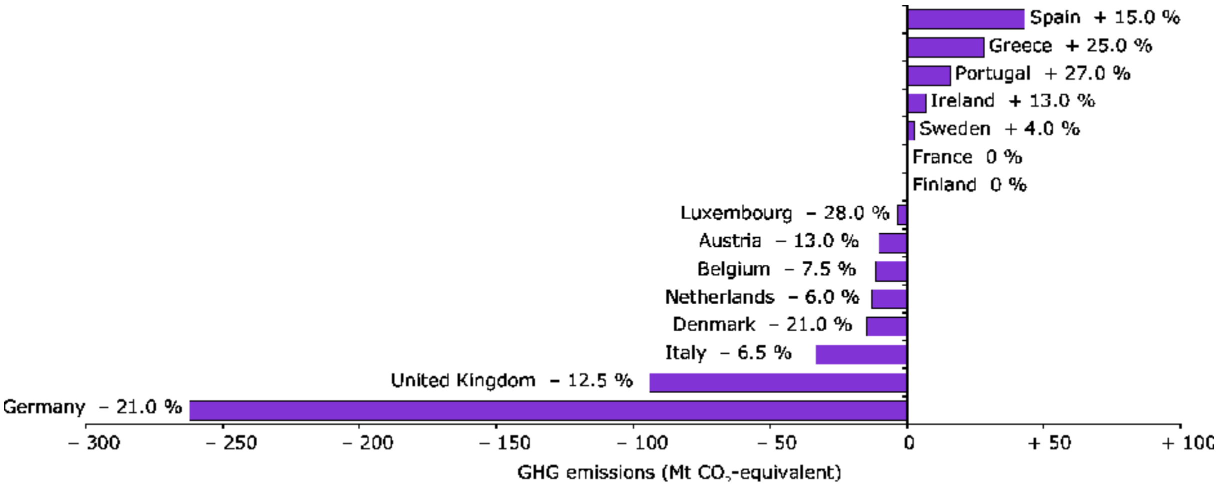

Figure 5.1: Reduction targets under the Burden Sharing Agreement

The new member states of the European Union are not covered by the 8% target and are therefore not part of the Burden Sharing Agreement but they have their own reduction objectives under the Kyoto Protocol[15], shown in figure 5.2[16].

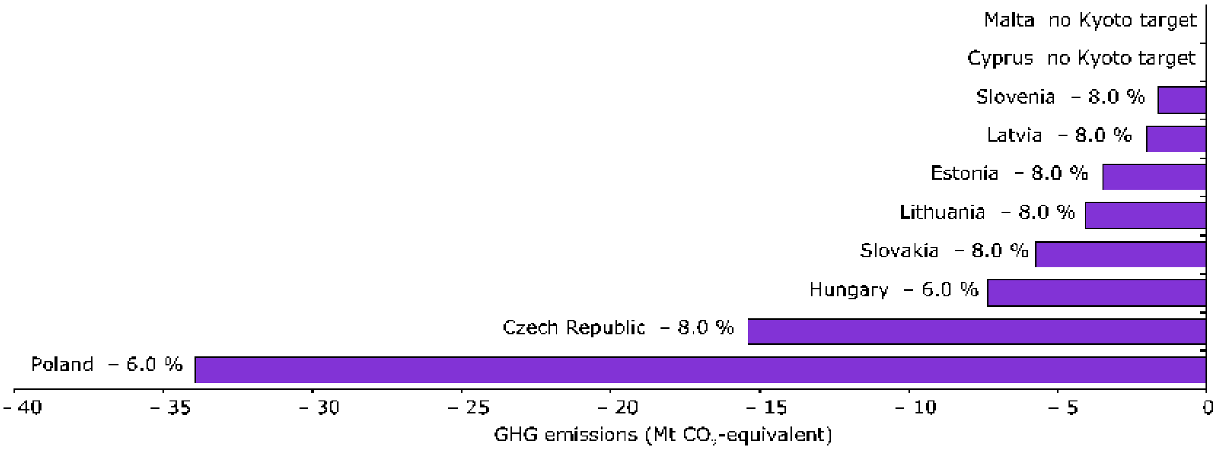

Figure 5.2: Reduction targets of the new member states

[14] Germany has to cut the highest amount of emissions in absolute terms even though Luxembourg has the most ambitious target in relative terms.
[15] Malta and Cyprus have no emission reduction targets.
[16] http://www.eea.europa.eu/data-and-maps/figures/greenhouse-gas-emission-targets-of-new-eu-ember-states-for-2008-2012-relative-to-base-year-emissions-under-the-kyoto-protocol-1, downloaded on June 11, 2010.

The European targets are very ambitious and so the realisation of the Kyoto commitment has imposed a serious problem. The European Commission estimated that by preceding the status quo, the Community would fail the 8% reduction target. Thus, the European Climate Change Programme (ECCP) was launched in 2000. Six working groups developed a package of 40 cost-efficient measures and recommendations. The main outcome was the implementation of an European Emissions Trading System (EU ETS). The European Commission estimated that emissions trading would bring cost advantages of about EUR 2.4 billion for the Community, the Kyoto target could consequently be reached with costs less than 0.1% of GDP (Müller, 2008, p.21). Furthermore, the Commission expects improvements in energy efficiency and security, reduction of air pollution and health costs, and increased employment. In 2003, Directive 2003/87/EC was passed and the EU ETS entered into force on January 1, 2005 (Müller, 2008, p.14).

5.2. Functionality of the EU ETS in the first and second trading period

The EU ETS developed in multiple phases. The pilot phase ranged from 2005 to 2007. Since the trading system is the first of this size, some start up time was needed to evaluate the functionality and correct certain weak points. The second phase corresponds with the obligation period of the Kyoto Protocol; it ranges from 2008 to 2012. For the third trading period from 2013 to 2020, many alterations are planned that shall improve its economic efficiency and ecologic reliability (see chapter 5.3.2).

5.2.1. Basic principles

The EU ETS is a market based instrument to lower greenhouse gas emissions in the European Union in a cost-efficient way. It is designed as cap and trade program, which means that a total quantity of emissions is settled politically, and the market determines where emission reductions take place (see chapter 4). Whereas Kyoto only provides the possibility of emissions trading between countries on national level, the EU ETS also enables trading between single companies.

EU Allowances (EUAs) are recognised community-wide. They are based on the same unit of measurement as AAUs under the Kyoto Protocol. One allowance equals one metric tonne of CO_2 equivalent[17]. Permits are site specific and non-transferable.

The EU ETS is the major climate policy instrument of the European Union and currently the biggest emissions trading system worldwide. Initially, it comprised the 15 EU member states, today it includes the EU 27 as well as Norway, Iceland and Liechtenstein. Countries that are joining the European Union are required to comply with the emissions trading directive. The EU ETS captures more than 10,000 industrial facilities that are responsible for nearly 50% of CO_2 emissions and for about 40% of the overall greenhouse gas emissions in the European Union. The trading system covers CO_2 emissions from large emitters in the power and heat generating industry and in selected energy intensive industrial sectors, accurately defined in Annex I of the directive[18] (Weirig, 2005, p.11).

In order to comply with the emissions trading directive, facility operators have to report their actual emissions to the responsible authority until April 30 of the subsequent year and deliver a corresponding amount of certificates. In the case of non-compliance, member states are obligated to inflict penalties. In the pilot phase, the directive stated that non-complying companies had to pay EU 40 per excessive tonne of CO_2 equivalent, in the second period this amount has risen to EUR 100. The comparatively small punishment in the first trading period was due to the fact that this time period was considered a learning process for the administrative system as well as for the participating companies. In addition to the monetary penalties, installations must make up for the shortfall in allowances in the following compliance period.

5.2.2. National Allocation Plans

The allocation of certificates is carried out new in each trading period. Each member state is obligated to develop a National Allocation Plan (NAP) for the upcoming

[17] Either one tonne of CO2 or a specific quantity of any other greenhouse gas defined in Annex 2 of the protocol with an equivalent warming potential.
[18] Combustion plants, oil refineries, coke ovens, iron and steel plants and factories making cement, glass, lime, bricks, ceramics, pulp and paper.

period before a specific key date. The NAPs define the total volume of traded emissions as well as the allocation among companies. Annex 3 of the emission trading directive determines 11 criteria that have to be considered when designing the plan[19]. Despite these criteria the member states have much freedom of design. The European Commission is responsible for monitoring the scheme and maintains the authority to veto NAPs.

Generally, the initial distribution of certificates can be allocated according to three methods. Firstly, the benchmarking method is predicated on the state of technology. It has a great incentive for innovation but the allocation determination is very costly. Secondly, the grandfathering method allocates permits free of charge according to past emissions. It is very popular because of its easy operability. The third alternative is the auctioning of certificates. The theoretical difference between auctioning and allocating certificates free of charge is accurately described in chapter 4.1.2. In the pilot phase, at least 95% of the certificates had to be allocated for free, in the second period this number has declined to 90%.

In the first and second trading period, all 27 member states allocated their allowances according to the grandfathering method. In some cases sectoral benchmarks or sector-specific growth factors were added. The base periods used in the allocation process covered one to ten years, in some countries facilities could exclude the year with the lowest emissions. Some countries also distinguished between process-related emissions and energy related emissions (Köppl, Thenius, Schleicher, 2008, p.7).

5.2.3. Emissions trading in praxis

Each member state has to appoint a public authority that controls the compliance with the trading rules and instructions. The governmental body only approves the

[19] First of all, the total quantity of traded certificates has to be compatible with the Kyoto target. The trading system should contribute as much as possible to the reduction target since emission reductions in sectors that are not covered by the EU ETS are likely to go hand in hand with higher costs. Furthermore, a member state must not allocate more certificates than necessary to cover the current or forecasted emissions in a specific sector. Unjustifiable preferential treatment has to be avoided in the allocation process, but member states should also account for unequal initial situations of facilities.

authorisation for greenhouse gas emissions if the company can verifiably monitor its emissions and report them to the authority. The reporting has to be done at any one time three months after the end of the calendar year. The reports are controlled and released by independent experts. If a report is not approved until March 31, the particular operator does not obtain any new certificates until a satisfactory report is presented.

Emission certificates exist only electronically. Any allocation, occupancy, transfer or cancellation of certificates is recorded in a specific electronic commercial register. Any natural or juridical person within the EU may trade and hold an account within a national registry. Stock exchanges that trade EU Allowances are, inter alia, the European Energy Exchange (EEX) in Leipzig, the European Climate Exchange (ECX) in Amsterdam, NordPool in Oslo, and PowerNext in Paris.

5.2.4. Special forms of compliance

Since 2005, member states can apply to the Commission to include (opt-in) installations or activities with thresholds lower than required in the directive. Since 2008 member states can also apply to include additional activities and installations that are not listed in the directive as well as further greenhouse gases. The Commission has the right to deny these requests for expansion.

In the first trading period, member states could also exclude (opt-out) certain installations from the EU ETS under the condition that these installations would realise their reduction requirements through other measures. Furthermore, the member state had to guarantee that there would not be any distortion of competition because of this exception. For opting-out installations, the approval of the Commission was also mandatory.

Operators of a certain branch have the possibility to form pools for the purpose of participating in and complying with the EU ETS. The Commission has the capability to deny a member state’s request. The possibility of pooling will expire at the end of the second period.

In each case, certificates have to be applied in the period in which they are issued. Within specific periods, the trading system provides the opportunity to transfer unused permits to the next year. This is called emissions banking. An exemption was the interface between the first and the second period, when member states had to cancel and re-issue unused allowances. Starting with the second trading period, certificates can be taken along into subsequent periods.

Installations also have the possibility to borrow allowances in order to meet their reduction targets. If an operator calls upon this alternative for the prior year, he either has to purchase additional permits or reduce more emissions than required. However, between periods, borrowing is not possible.

Furthermore, as on regular stock markets, emission allowances can be traded via derivative activities, inter alia, Forwards, Futures, Options, and Swaps.

5.2.5. The Linking Directive

The Kyoto Protocol provides the opportunity to use flexible instruments in order to comply with the reduction target (see chapter 2.2.3). The Linking Directive 2004/101/EC integrates credits earned by Joint Implementation (ERUs) and the Clean Development Mechanism (CERs) within the EU ETS. These credits can be exchanged on a one to one basis with EUAs. Therefore, companies have the possibility to receive certificates through investments in international projects. CERs, generated by emission reduction projects in developing countries, can be officially used since 2005. ERUs, achieved through projects in other industrialised nations, are accepted since 2008. Member states must declare in their NAPs which percentage of their installations' allowances may be converted. The Commission retains the possibility of rejection because the flexible mechanisms of the Kyoto Protocol are only meant to have supplementary character. In the first period, CERs and ERUs from land-use change and forestry projects were not eligible; in the second period credits are excluded that are generated from nuclear projects.

5.3. Beyond 2013

The Kyoto Protocol expires in December 2012. Since the world's countries have not agreed on any commitments beyond this period, the future of international climate protection is very unpredictable today (see chapter 2.2.2). Nevertheless, the European Union plans to further reduce its greenhouse gas emissions, continue and develop its emissions trading system and keep its leading position in international climate protection.

5.3.1. The climate strategy package

In 2007, the Commission made some proposals that were mainly approved by the European Council. Point of origin was the strategic target to limit the rise of the global temperature to 2° Celsius at most compared to pre-industrial times (Ziesing, 2009, p.109). Therefore, emissions are to be reduced by 60% to 80% compared to 1990 levels. In January 2008, the Commission passed a comprehensive climate- and energy package that is meant to create binding targets for the EU member states for the year 2020.

The package states that greenhouse gas emissions are to decrease by 20% compared to 1990 levels or by 30% if other industrialised countries also participate[20]. Therefore, energy productivity has to increase to such an extent that the adjusted energy consumption will be reduced by 20% in 2020. The portion of renewable energies has to increase to up to 20% of total energy consumption. Furthermore, the fraction of bio fuels has to rise to up to 10% compared to the total petroleum and diesel consumption (Ziesing, 2009, p.110).

The Commission also proposed guidelines for the member states to guarantee the attainment of these targets. Sectors that participate in the EU ETS have to reduce their greenhouse gas emissions by 21% compared to 2005 (Ziesing, 2009, p.110). In addition there are various reduction targets in those sectors that do not participate in the trading system.

[20] Of course, this scenario has become very unlikely after the unfruitful climate protection negotiations in Copenhagen in 2009.

In the light of the present pollution development, these targets imply remarkable efforts in the policy areas of energy and climate protection. Industrial representatives already fear competitive disadvantages caused by carbon leakage (see chapter 6.9).

5.3.2. Future alterations in the EU ETS (the third trading period)

In 2008 the European institutions passed an amendment of the emissions trading directive 2003/87/EC and, thus, agreed on the future of the EU ETS (Müller, 2009, p.35). Starting with 2013 the NAPs will be replaced by a common single cap. Because of the abandonment of the member states' NAPs, environmental effectiveness and target achieving becomes better calculable and predictable.

The future development of the total quantity of certificates is exactly stipulated in the directive. Starting in 2010, the average number of certificates allocated in the second trading period will be reduced by 1.74% annually (Müller, 2009, p.38). Therefore, the cap declines during the entire trading period.

From 2013 on, the allocation method will differ between sectors. For electricity generation, there will be no cost-free allocation anymore, exempted are only some operators in Eastern European countries. Heat generation and industries that are not affected by relocations will face a slow transition towards higher amounts of auctioning. From 2013 on, 20% of the certificates allocated to these sectors will be auctioned, and until 2020 this portion will increase to up to 70%. Facilities in the energy intensive industry will receive certificates determined by benchmarks because of strong international competition (Müller, 2009, p.38). .

In the current emissions trading system, the smallest ¾ of all installations account for only 5.1% of the total verified emissions whereas the biggest 1.8% of all installations represent half of the emissions within the EU ETS (Köppl, Thenius, Schleicher, 2008, p.19). These small installations are connected with excessive transaction costs compared to their reduction potential. Therefore, in the new proposal it is intended that installations with a thermal capacity of 20 to 25 MW, emitting less than 10,000 tonnes of CO_2 per year, can be excluded from the EU ETS if other emission reduction measures are applied (Köppl, Thenius, Schleicher, 2008, p.22).

Because the EU ETS is limited to certain sectors, marginal abatement costs are only equalised in a subtotal part of the economy. In turn the trading system misses its goal of minimising overall compliance costs. Therefore, economists think about expanding the emissions trading system to further sectors. From 2012 on, aviation is included in the trading system, and further industrial sectors are likely to follow. Furthermore, during the first two periods, only CO_2 was covered in the emissions trading system. With the start of the third period the trading system will also cover the other five Kyoto gases.

Not only will the design of the trading system change, the infrastructure will also face alterations. In 2013, a common Community registry will start, and the efficiency, transparency, and security of the trading system will be improved.

5.4. Does the theory work?

As described in chapter 4.1.1, the commitment to maximal values for environmental pollution is a political process which can lead to suboptimal solutions. In the case of the EU ETS, most countries feared that a very stringent enforcement of the emissions trading directive would harm their economies (see chapter 6.1). Thus, they allocated their certificates very loosely. This over-allocation resulted in a price drop of emission allowances (accurately described in chapter 6.2), which seriously endangered the functionality of the trading system.

Because of this unfair process, the trading system could not profit from its great theoretical advantages. The attribute of economic efficiency, best shown in the example in chapter 4.2.1.1, depends on certain assumptions that were not fulfilled during the first trading period. Furthermore, the extensive allocation and the low certificate price endangered the ecological effectiveness of the trading system (described in chapter 4.2.2).

On the other hand, the gentle transition in Europe from a situation without any emission restrictions to an emissions trading system smartly solved the problem of regulative compliance (see chapter 4.2.3).

Other challenges than the extensive allocation of certificates did not gain much attention. Because of the low certificate price, transaction and administration costs, outlined in chapter 4.2.1.4, did not considerably matter. Furthermore, the stock markets functioned well and now market participants already have substantial knowledge about the trading process. Fears in connection with the Clean Development Mechanism (chapter 6.7) and carbon leakage (chapter 6.9) also did not turn into reality because of the low price of emission permits but could become more important in the second and third trading period.

6. Issues and challenges

Chapter 4 accurately explains the theoretical functionality of a tradable permits solution. Of course, the great theoretical advantages like cost-efficiency were major reasons for the European Commission to propose the introduction of the EU ETS in the first place. The design of the trading system was influenced by various interests of the European Commission, member states and industrial lobbying groups. Therefore, the trading system did not have the optimal preconditions it would have needed to reach its full potential. The upcoming chapter addresses current issues and challenges and points out possible solutions to improve the emissions trading system in future periods.

6.1. The design of National Allocation Plans

The National Allocation Plans contain the distribution of the national emission budgets among the individual sectors participating or not participating in the European emissions trading system as well as the criteria for the allocation of the certificates among the facilities themselves.

In the legal system of the European Union, directives do not work effectuate but have to be transformed into national law by the individual member states. Therefore, important decision-making authorities remain at national levels. In the first and second trading period, the total quantity of emissions covered by the EU ETS has not been regulated by one single European authority but by the individual member states. This decentralised approach can be explained with the help of the subsidiary principle, the heterogeneous structure of the European industry, and the different commitments under the Burden Sharing Agreement (Müller, 2009, p.24).

The construction of an emissions trading scheme of this great size requires enormous organisational and administrative efforts. After all, twenty-five national governments are included in the process. Furthermore, the European wide regulation is complicated by the fact that within the European Union various sectors face competition to different degrees.

Unfortunately, the decentralised system has created a tendency towards low environmental ambitions. Chapter 4.1.1 explains that the total emissions volume depends not only on efficiency but also on other factors, for example political feasibility. In the case of the EU ETS, no country wants to disadvantage its economy. Therefore, a strong incentive for extensive allocation of certificates has appeared. Lobbying groups and economic stakeholders have also influenced political decision-makers to design the NAPs to their advantage (Müller, 2008, p.39).

The extensive allocation of permits requires large emission reductions in sectors outside the EU ETS that are likely to come along with higher marginal abatement costs. On the other hand, the moderate reduction targets and the system of grandfathering created a soft transition for the European industry sectors to the emissions trading system in the first trading period.

During the development of the National Allocation Plans, some difficulties occurred. The allocation of the certificates is a fundamental aspect of the trading system; the challenge is to find and establish a proper allocation formula. At the beginning of the second trading period, the Commission had to strongly interfere with the definition of the national caps and the allocation process due to pronounced long positions in many countries and sectors during the pilot phase (Köppl, Thenius, Schleicher, 2008, p.22). Sometimes the allocated quantities even exceeded the estimated emissions. This excessive allocation of permits endangered the Kyoto targets.

No member state took the Kyoto basic years as reference years. The official explanation was insufficient data, but the hidden agenda was probably the fact that emissions sharply increased during the 1990s. Because the reference years vary among member states international comparability is very hard. Some member states also intended to ex-post adjust their allocation which would disrupt the market mechanism and create uncertainties for companies. Furthermore, there were difficulties with the interpretation of the term “facility” that also led to extensive certificates allocation (Stix, 2007, p.29).

The Cap and Trade system is usually regarded as an especially cost-efficient instrument, but in this context, important connections to reality are often overseen. Economists usually assume a perfectly functioning certificates market and underestimate costs for the establishment and maintenance of such markets.

The Czech Republic, Estonia, Hungary, Latvia, Slovakia and Poland claimed at the court that the stringent cuts of their second NAPs would damage their economic development (Müller, 2008, p.44). If the court rules in favour for them, this will be a strong backlash for the EU ETS.

6.2. Price development and the over-allocation of certificates

As described in chapter 6.1, the decentralised approach to let member states decide individually about important parameters like the emission caps and the allocation formulas led to low environmental ambitiousness and an over-allocation of emission certificates. This overall long position resulted in significant price drops in 2006 and 2007 down to a few cents per certificate which endangered the functionality of the trading system during the first trading period.

6.2.1 Factors affecting the certificates market

The CO_2 market is influenced by several different parameters. One major factor and, therefore, one of the most important market drivers is the design of the National Allocation Plans. The stepwise stringency of the allocated allowances is of crucial importance for the trading system to work and for reasonable prices to develop.

Another important factor for the development of the certificates price is the linking of the trading system with the Kyoto mechanisms, namely Joint Implementation and the Clean Development Mechanism. The conjunction enhances liquidity and smoothes the price development.

Weather circumstances have a dual impact on the production of CO_2. Hot summers impact the demand for energy because of increased use of air conditioning. On the other hand, they reduce the output of hydroelectric power plants. Cold winters, on the contrary, increase the demand for heating (Müller, 2009, p.29). At low temperatures, the consumption of energy rises. In turn, this means an increase in the demand for CO_2 in electricity and energy facilities increases too. Furthermore, rainfall and wind velocity influence the share of renewable energy which in turn influences the CO_2 price level.

CO_2 production is also affected by differences in fuel prices. If the price for carbon or gas changes, an alteration of the utilisation is likely and this changes the quantity of emitted CO_2. Especially the significant price increase in import coal has caused gas to become comparatively cheap up until now (Draxler, 2008, p.117).

Another important factor for the demand of carbon dioxide is economic growth. This relationship is described in the Environmental Kuznets Curve (EKC) that implies a connection between the economic performance (GNP per capita) and the degree of environmental damage. Generally, a converse U-shaped interrelation is assumed, meaning that emissions rise with economic growth until a certain economic standard has been reached and then decline again (Stix, 2007, p.33-34). In the light of this, especially the high economic growth of emerging markets like China and India, which have never agreed to any pollution restrictions, could foil the emission reductions of industrialised nations and, therefore, endanger the global climate.

If technological progress leads to new and cheaper possibilities to abate CO_2, the demand for EUAs will decline. Of course, this is a very slow process; sudden technological improvements that lead to strong price shifts are not to be expected. Besides all these factors, speculators cause further movements on the allowances market.

6.2.2 Over-allocation of emission certificates

From 2005 to 2007, EUAs for 2,090 million tonnes of CO_2 equivalents were allocated on average each year. In comparison only 2.040 million tonnes were verified. This means that the emissions market was long with 70 million tonnes per year[21], which corresponds to 3.4% of the allocated allowances. During these years, only 5 out of 24 member states[22] were in a short position, all other countries were in a long position (Köppl, Thenius, Schleicher, 2008, p.14).

This overall long position implies very low carbon prices or even prices close to zero. Unfortunately, a positive price on carbon is one of the main prerequisites for the system to render the intended effect of transforming the European energy system. Hence, the continuing long position poses a serious threat to the effectiveness of the trading scheme.

[21] The emissions market is in a long position when the sellers of permits generally produce less CO_2 than permitted. On the other hand, a market is in a short position when market participants pollute more tonnes of CO_2 compared to the number of permits allocated.
[22] UK, Spain, Italy, Ireland and Slovenia

6.2.3 The development of the certificates price

Figure 6.1[23] shows the price development and the traded volume of EU Allowances on the European Energy Exchange in Leipzig, Germany. During 2005 and the first quarter of 2006, allowance prices were constantly strong. Traders feared a shortage of certificates and in April 2006 the price reached a maximum of EUR 30.5 per ton of CO_2.

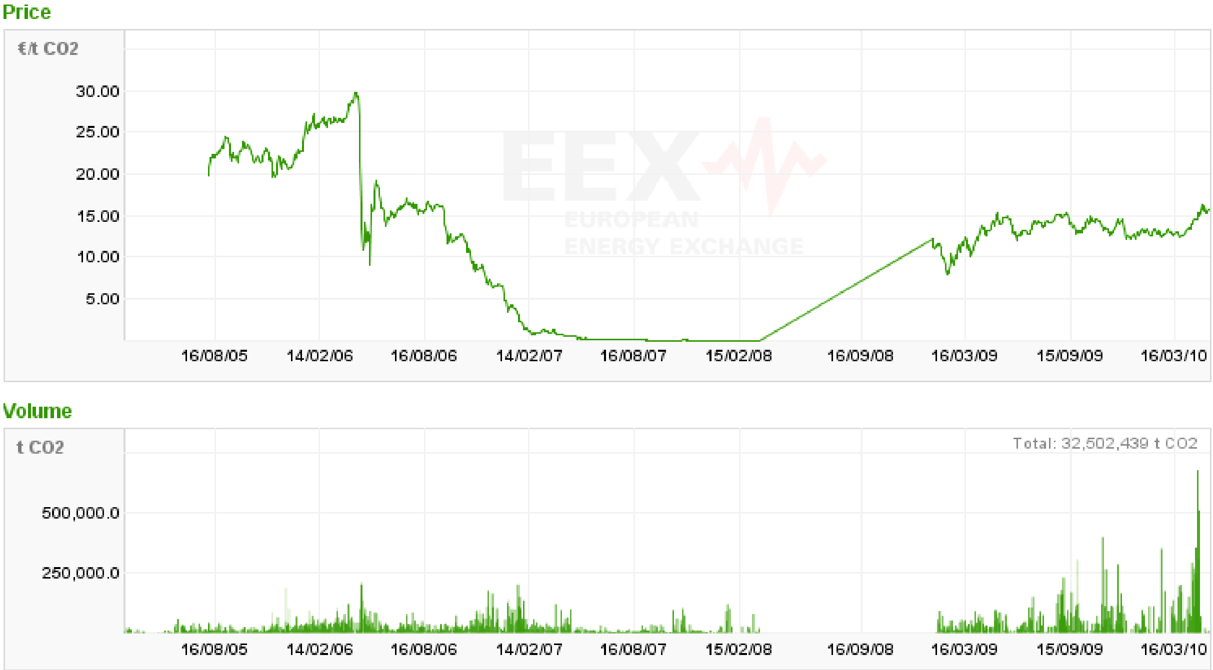

Figure 6.1: Price development and traded volume of EUA certificates on the European Energy Exchange

At the end of April, the service provider Point Carbon announced that the French industry would emit 12% less CO_2 in 2005 compared to the allocated certificates. Therefore, 18 million more certificates than expected were available (Draxler, 2008, p.113). When the market participants realised that the market was in an overall long position, the price of CO_2 certificates collapsed dramatically. Other countries also had a surplus of CO_2 permits. As a result, the price of CO_2 certificates bisected and almost reached zero at the end of the first trading period in 2007.

[23] http://www.eex.com/de/Marktdaten/Handelsdaten/Emissionsrechte/EU%20Emission%20Allowances%0|%20Spotmarkt/EU%20Emission%20Allowances%20Chart%20|%20Spotmarkt/spot-eua-chart/2010-05-14/0/0/a, downloaded on June 29, 2010

For the second trading period, the Commission cut emission allowances by about 10% to re-establish a viable price for CO_2. So far, this measure has led to a stabilization of allowance prices. Analysts now expect a price of about EUR 23 for one ton CO_2 (Müller, 2008, p.41).

6.3. Regional phenomena

Between 1990 and 2006, the EU 15 managed a greenhouse gas reduction of -2.2% (EU 27: -7.7%) (Müller, 2008, p.35-36). Unfortunately, this moderate reduction was mainly caused by two single and non-repeatable effects of the two greatest European emitters Germany and the United Kingdom.

Germany benefited from the reunion with the former German Democratic Republic that faced a breakdown of its industry because of the economic transformation in the 1990s (Ziesing, 2009, p.105). Therefore, the German greenhouse gas emissions declined without any additional effort and it was very easy for Germany to reach its ambitious reduction target. This phenomenon is called the “Berlin Wall” effect.

The UK, on the other hand, profited from the liberalisation of its energy market that caused a combustible change from oil and coal towards gas (Müller, 2008, p.38). Because of these phenomena and the domination of Germany and UK in the European emissions market, the European Union as a whole is on a good way to reach its Kyoto target. Of course, these two effects can not be repeated. Therefore further efforts will be necessary to continuously reduce pollution and comply with international agreements.

The new member states of the European Union faced a similar effect like Germany after the reunion with the former German Democratic Republic. Most Eastern European countries are over-endowed with AAUs due to the economic recession and the collapse of the heavy industry and mining sector in the 1990s. Thus, their Kyoto target (-6.0% or -8.0%) is above their expected emissions for 2012 (Weirig, 2005, p.33). These excess Kyoto allowances are called “hot air”. Because “hot air” can be sold in large amounts on the international market, the price declines and destabilises the permits market. The trading of “hot air” was one of the major reasons why the supplementarity clause was introduced into the Kyoto Protocol, stating that domestic emission reduction efforts should have first priority and the flexible mechanisms should only be supplementary.

6.4. Auctioning versus grandfathering

During the first two trading periods, the emissions trading directive has prescribed that to a large extent the allocation of certificates has had to be free of charge. This regulation has been crucial in the political process to resolve the resistance of the energy-intensive industry.

In the case of free allocation as well as in the case of auctioning, an aggregated plan is necessary to define the upper limit of emission certificates and, therefore, to substantially determine the ecological effectiveness of the trading system. By using grandfathering (that is allocating certificates according to historical emissions), additionally to the macro plan, a complete micro plan is needed for the allocation among facilities. Therefore, very high administrative costs are created. Furthermore, the system leads to a preferential treatment of individual facilities very easily and, therefore, to distortion of competition.

Of course, administrative costs also appear when certificates are auctioned. They include development costs of the auction design, costs for the construction of the required infrastructure and continuous administrative costs for the operation (Müller, 2009, p.37). Furthermore, market participants face costs which strongly depend on the number of auctions as well as on the auction design.

Regarding the efficiency of the trading system (described in chapter 4), the equivalence of auctioning and cost-free allocation depends on the ability of the companies to integrate the opportunity costs of gratis certificates into their management decisions. If a company has to purchase CO_2 certificates by auction, its variable costs (more precisely its marginal production costs) increase. On the other hand, these costs also have to be considered in the case of cost-free allocation because the emission of one ton of CO_2 annihilates the possibility to sell the certificate on the market. It can be argued that auctioning certificates leads to an actual increase in production costs because companies do not always maximise their profit in due consideration of the opportunity costs.

Furthermore, less grandfathering and more auctioning would reduce some of the main market uncertainties, create less volatile prices, provide for reliable price signals on the market, and probably reduce administrative costs. Because the opportunity costs of CO_2 certificates are already included in the market prices, increased auctioning is not likely to increase energy prices. Furthermore, the problem of how to deal with new entrants into the emissions trading system is solved automatically. Additionally, by auctioning the certificates instead of allocating them cost-free, the extra profits of the companies would become public revenues and could, therefore be used meaningfully, inter alia for further emission reduction activities.

As described in chapter 5.3.2, auctioning will become the standard allocation method in future trading periods.

6.5. Windfall profits

As mentioned in chapter 6.4, in the first trading period, the allocation of emission licences among companies was generally free of charge. Companies, especially in the energy intensive industry, recorded these gratis licences as opportunity costs at fair market value. Therefore, these opportunity costs were passed on to the electricity tariffs and the companies realised profits in the billions (Brouns, Witt, 2008, p.75). Subsequently, indirectly existing market structures were strengthened and the ecological steering effects that were meant to create incentives for new investments were undermined.

Passing on additional costs caused by the emission trading system depends on three factors (Köppl, Thenius, Schleicher, 2008, p.28). Firstly, sectors with a relatively low elasticity of demand are able to raise the prices of their products (without inducing strong reductions in demand). Secondly, low competition within the market also increases the extent to which prices can be raised as a reaction to increased input costs. Finally, the geography of the sector's market matters because the competitiveness of European companies could be influenced by companies outside the EU that do not face emission constraints. The same distortions can also appear due to different approaches of the member states regarding the stringency of their NAPs, since also in this situation sectors in different EU countries are exposed to negative effects to different extents.

The empirical evidence so far suggests that windfall profits happen but they vary considerably across countries and sectors. It depends on a number of factors which determine the industry structure and competition within the market if companies can easily price in certificate costs to consumer prices. The highest windfall profits are generated by the electricity sector (Köppl, Thenius, Schleicher, 2008, p.27).

6.6. The prohibition of emissions banking between periods

As described in chapter 5.2.4, banking of emission permits was not possible between the first and the second trading period. Hence, the decision horizon was reduced significantly, which contributed to the high volatility of CO_2 prices.

Emissions banking has several positive consequences. It reduces the overall enforcement costs because of inter-temporal flexibility and makes it possible for companies to create a safety buffer of certificates. Therefore, companies are able to manage abatement efforts more efficiently which in turn leads to increased efficiency Banking also creates better price signals on the market.

An explanation why member states tend to prohibit certificates banking between periods is that the Kyoto targets have only been in effect since 2008. If many allowances were assigned into this period, single member states could miss their reduction targets.

6.7. Clean Development Mechanism and the threat of abuse

The Clean Development Mechanism is designed to promote projects in third world countries that contribute to climate protection. Since climate change is a global problem and it makes no difference where on earth emission reductions are accomplished, it is generally reasonable to reduce pollution in developing countries because environmental protection activities are usually much cheaper in these countries than in industrialised nations[24].

The connection of the EU ETS with the flexible instruments JI and CDM follows the same line of argumentation. Technological transfer, the sustainable development of host countries, the advancement of liquidity of the trading system, and increased quantity and diversity of possible options for compliance are only some of many important advantages (Sterk, Arens, 2008, p.43). Bottom line, the linking between the flexible Kyoto instruments and the EU ETS lowers the allowance price and, therefore, reduces compliance costs for the member states as well as for the facilities that participate in the Emissions Trading System.

Despite these arguments, it was one of the most important goals of European delegates during the Kyoto negotiations that domestic actions have to be prioritised over the purchase of certificates from abroad. After all, the main target of the protocol is a change in domestic pollution behaviour and the start of a long-term transformation of the energy infrastructure towards sustainable energy sources. Furthermore, domestic actions also bring along various beneficial side-effects like enhanced security of the energy supply and reduced air pollution through exhausts. Greater use of the flexible Kyoto mechanisms, thus, reduces the costs of compliance with the EU ETS in the short run but also bears the risk that domestic reduction activities are not enforced. By extensive use of the flexible instruments, short-dated commercial profit-maximisation and long-term economic efficiency come into conflict.

Meanwhile it seems that the European Union has abandoned its goal of prioritising domestic actions. The quantity of JI and CDM credits permitted in the EU ETS is almost identical with the necessary reduction quantity in Europe although the

[24] During the first trading period, credits gained with the help of the flexible instruments JI and CDM were hardly used because of the very low certificate price.

Commission has significantly reduced the number of certificates allocated by the member states in the second trading period. Therefore, most member states are expected to meet their Kyoto targets not because of domestic reduction activities but only because of the acquisition of certificates (Sterk, Arens, 2008, p.37).

Besides, the utilisation of JI and CDM faces further structural problems that undermine their ecological value as well as their contribution to the development of third world countries. The projects' crediting process is double-bounded. Firstly, the member states have to specify in their National Allocation Plans to what extent they are planning to use the flexible mechanisms in order to comply with their Kyoto targets. Secondly, facility operators can use CERs and ERUs to a certain percentage. This regulation requires the coordination of public and private purchases of certificates and, therefore, high transaction and information costs as well as a highly developed communication infrastructure.

For the verification of additionality of CDM projects, the difference between the baseline (the expected development of emissions in absence of the specific CDM project) and the quantity of actual greenhouse gas emissions is calculated. Of course, the reference scenario is entirely based on estimations. Therefore, it is only a hypothesis, not a hard empirical fact. Hence, the estimated scenario as well as the certificate of additionality will always be assailable. In the past, many ominous projects have stoked the suspicion of abusive practices (Witt, Moritz, 2008, p.91).

The major weakness of the CDM verification process is that all involved participants (investors, validators, host- as well as investing countries) have the same interest which is to maximise the certificates generated from the project at the least costs possible. This situation leads to a great abusive potential. A key element in this process is the missing independence of the validators who have the responsibility to guarantee the proper course and the projects' additionality. Validating companies, also called Designated Operational Entities, are accredited by the CDM executive council of the United Nations, but they are appointed by the project executing organisations. Because these companies are often dependent on subsequent appointments, they are under great pressure to grant positive notifications. Of course, CDM projects without additionality lead to a global increase of greenhouse gas emissions. The climate protection targets of the Kyoto Protocol as well as the European Emissions Trading system would, therefore, be reduced to absurdity.

CDM activities also face the criticism that, in reality, they hardly contribute to technological transfer and the sustainable development of third world countries. Only little capital is spent for efficiency improvements and renewable energy. Furthermore, there are hardly any CDM projects in Africa. In addition, many CDM projects are accompanied by negative ecological and social side effects (Witt, Moritz, 2008, p.102). Moreover, the Kyoto instrument can create incentives to produce climate killers like fluoroform (CHF_3) that has a global warming potential of about 15,000 CO_2 equivalents, so that they can subsequently be decontaminated profitably by earning CDM credits (Brunnengräber, 2008, p.142).

Bottom line, the implementation of reasonable quality standards would naturally limit the number of generated certificates. Therefore, the certificate price would increase. Subsequently also high-valued projects (e.g. renewable energy projects) would become financially attractive.

6.8. The possibility of connecting emissions trading systems

The connection of the EU ETS with other emissions trading systems in industrialised countries, called the linking process, has several advantages. From an economic perspective, a greater market creates cheaper and more efficient possibilities for abatement. Furthermore, the price development could be smoothed. From the international perspective, a connected market and the development of emissions trading systems in various countries could be an important impulse for the advancement of the international climate protection policy for the time beyond 2012 (Schüle, Sterk, Duckat, 2008, p.178). Of course, geographically expanding the European Emissions Trading System only addresses cost-efficiency but not the total quantity of global emissions.

The EU ETS is potentially open to link agreements with other emissions trading systems. The best example for the success of the linking process is Norway which created its own emissions trading system which was connected to the EU ETS in 2008. Other industrialised countries like Switzerland, Canada, Japan, Australia, and New Zealand discuss the implementation of comparable systems or already maintain trading systems (Schüle, Sterk, Duckat, 2008, p.178-180). On the intra-national level the Regional Greenhouse Gas Initiative should be mentioned that is implemented in ten eastern and north-eastern US states. In 2007 the International Carbon Action Partnership (ICAP) was launched. It is a forum with stakeholders of over 25 countries that aims to support the linkage between the EU ETS and other compatible trading systems.

Of course, considerable differences in the design of the various emissions trading systems can not be neglected. Therefore, the connection between the EU ETS and other trading systems could go hand in hand with complex problems.

6.9. Global climate protection and carbon leakage

The Kyoto Protocol distinguishes between industrialised and developing countries. Only industrialised countries are obliged to constrain their greenhouse gas emissions, the developing countries have no targets whatsoever. The basic idea behind this regulation is the costs-by-cause principle, saying that the industrialised countries are responsible for global warming in the first place; poorer countries, on the other hand, should have a right to develop. However, it must be noted that greenhouse gas pollution is a pure collective good. Climate change is a global problem and that it does not matter where pollution takes place. Since some of the world's largest and fastest growing emitters[25] continue to increase their greenhouse gas emissions, the reduction efforts done by the European Union are likely to be outweighed by the increasing pollution in other parts of the world.

In developing countries and emerging markets (non-Annex-I countries), greenhouse gas emissions are increasing especially fast[26]. In 2007 they were more than doubled

[25] China and India are developing countries and are therefore not committed to any emission reductions. Furthermore, some industrialised countries like the United States have not signed the protocol and, therefore, do not participate in climate protection.
[26] This phenomenon can be explained by the Environmental Kuznets Curve (see chapter 6.2.1)

compared to 1990. For the first time, emissions in these countries exceeded the emissions in the rest of the world (Ziesing, 2009, p.102). Of course, the emissions per capita in non-Annex-I countries were only one fourth of the per capita emissions in industrialized nations (Ziesing, 2009, p.102-103).

Companies in countries with stringent reduction regulations have a competitive disadvantage compared to companies that are located in countries without reduction targets. Either costs rise because of investments in carbon abatement activities or because of purchases of emission certificates. In addition, indirect costs can occur because of higher electricity prices that are passed on by electricity producers. Thus, it becomes interesting for domestic companies to relocate carbon or energy intensive industries to countries without CO_2 regulations (Köppl, Thenius, Schleicher, 2008, p.26). This phenomenon is called “carbon leakage” and is one of the most striking arguments against emission reduction policies. Of course, if future investments in the concerned sectors happen more often in developing countries, carbon leakage does not only result in lower employment and growth rates in Europe but also undermines the environmental effectiveness of the EU ETS.

The negative competitiveness caused by the EU ETS can be reduced in two different ways. Firstly, alleviation measures change the incentive structure of the scheme and the functioning of the market. They include the recycling of revenues generated from auctioning, the limitation of allowance prices, for example by higher proportions of JI and CDM credits, and an allocation system based on benchmarks. Compensation measures, on the other hand, include tax breaks, reduction of burdens, government subsidies and the redistribution of “windfall taxes” (Köppl, Thenius, Schleicher, 2008, p.32). Furthermore, while in the short to medium term environmental regulations usually have negative impact on the regulated industries due to compliance costs, industries can benefit from first mover advantages in the longer term.

Most studies conclude that carbon leakage is generally a minor threat and only limited to some industrial sectors. However, the effects strongly depend on the proper implementation of the trading system. A weak or inconsistent implementation raises the threat level to the competitiveness of the European industry (Köppl, Thenius, Schleicher, 2008, p.31).

To sum up, it can be said that as long as there is no worldwide cooperation in climate protection, the EU ETS is an ecologically inefficient system. Only if all big polluters participate in climate protection, emissions trading will become an effective tool to combat global warming. Therefore, a sustainable solution depends on the question if the United States, together with China the word's greatest emitter, will commit to precise emissions reduction targets and if the less developed countries, especially China and India, whose emissions are growing rapidly, will accede to pollution boundaries.

7. Summary and conclusions

The European Emissions Trading System, established in 2005, is the most important and most innovative policy tool that the European Union uses to comply with its Kyoto targets. Tradable permits are generally judged very positively in economic literature, but first experiences show that the devil is in the details. The most significant issue during the first trading period of the EU ETS was the collapse of the certificates price down to a few cents in 2007.

This price drop was a result of the extensive over-allocation of certificates in many European member states. Europe hardly had any experience with tradable permits for environmental protection, and no country wanted to disadvantage its economy. Therefore, the incentive was very high to loosely allocate certificates free of charge. The decentralised approach to let the member states decide on fundamental aspects like the total quantity of certificates and the allocation formulas turned out to be ineligible and seriously endangered the functionality of the trading system. On the other hand, implementing these regulations was probably the only way to break the resistance of industrial lobbying groups.

The trading system also faced various other problems. Companies earned billions by pricing in their gratis certificates in consumer prices. Furthermore, the Clean Development Mechanism was an easy target for abusive behaviour. In spite of these challenges, it has to be mentioned that climate policy in the European Union is a continuous learning process. Considering the improvements from the first to the second period and the promising alterations that are planned for the third trading period, the future prospects of the European Emissions Trading System are not so dismal after all.

Since the EU ETS is unique in its size and internationality, it is understandable that some start up time is needed. Now, European policy makers are facing the challenge to centralise the decision-making process, to ensure reasonable and restrictive cuts and to introduce a fair allocation method. The alterations that are planned for the third trading period already fulfil most of the requirements mentioned above.

Unfortunately, even if climate protection in Europe worked perfectly, it would not have any mentionable effect on global warming whatsoever. Only if all significant polluters worldwide commit to greenhouse gas reduction and limitation obligations, climate protection can be seriously approached. Of course, an efficiently functioning trading system in Europe would be a brilliant argument for environmental protection proponents and a great motivation for unwilling actors to reconsider their point of view.

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Professional experience

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